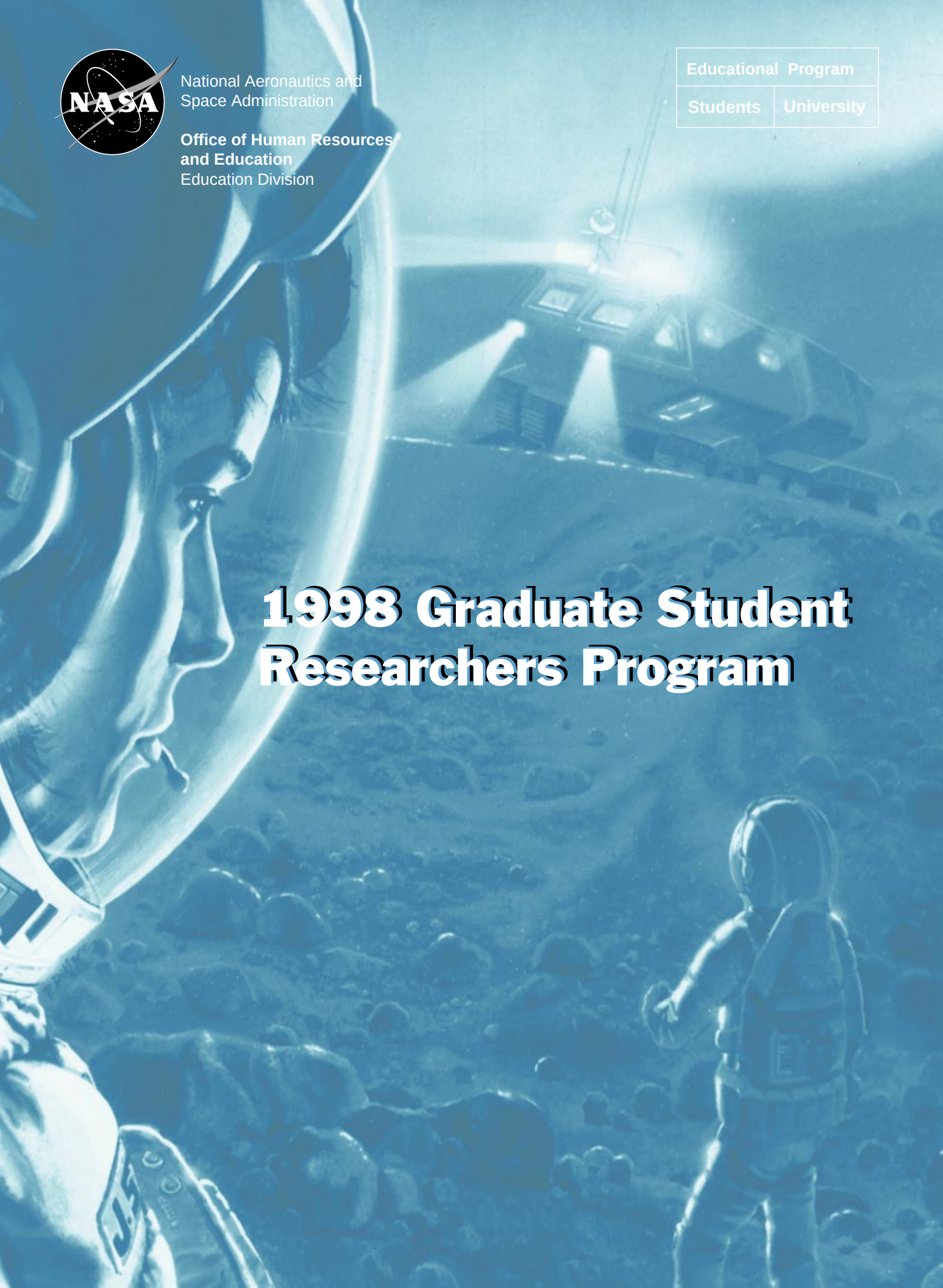


National Aeronautics and Space Administration

Office of Human Resources and Education
Education Division

Educational Program	
Students	University

1998 Graduate Student Researchers Program

About the Cover: Artist concept, “Humans on the surface of Mars.”

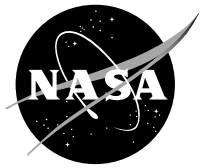
This photo was selected for the cover because it was a favorite of Ms. Georgia LeSane.

Dedication

Ms. Georgia LeSane

The 1998 Graduate Student Researchers Program book is dedicated to the memory of Ms. Georgia LeSane. Georgia served as a GSRP Administrator for the Microgravity and Life Sciences and Applications component of the program for several years. She will be greatly missed by all who knew her, especially the many students who benefited by her dedication and advocacy. Georgia was particularly concerned with providing increased opportunities for underrepresented and underserved students of African American, Hispanic, and Native American decent, as well as the disabled and women. We will honor her memory by increasing our commitment to these students.

1998 NASA Graduate Student Researchers Program



NASA Headquarters
Office of Human Resources
and Education
Education Division
Washington, DC 20546

EP-1997-10-353-HQ

Table of Contents

From the National GSRP Manager **4**

From the NASA Strategic Plan **5**

NASA Centers and Facilities **14**

NASA Education Framework **15**

Graduate Student Researchers Program **16**

Preparation of Proposal **19**

Program Administration **20**

Disciplines at NASA Centers **22**

Areas of Research Activities at NASA Centers

NASA Headquarters

Office of Space Science 25

Office of Life and Microgravity Sciences and Applications 27

Ames Research Center 29

Hugh L. Dryden Flight Research Center 37

Goddard Space Flight Center 41

Jet Propulsion Laboratory 57

Lyndon B. Johnson Space Center 67

John F. Kennedy Space Center 75

Langley Research Center 81

Lewis Research Center 91

George C. Marshall Space Flight Center 103

John C. Stennis Space Center 113

Forms **119**

- Proposal Cover Sheet
- Abstract and Budget Form
- Debarment Certification
- Drug-Free Certification

Other NASA Fellowship Programs

Earth System Science Fellowship 132

Space Grant College and Fellowship Program 133

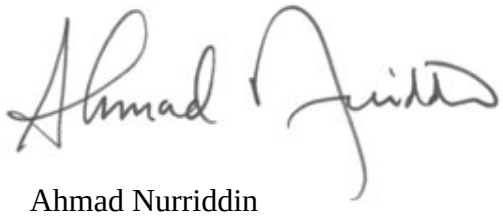
FROM THE NATIONAL GSRP MANAGER

Does life exist elsewhere than on our planet? What can we do about greenhouse warming here on Earth? Did our universe really start with a Big Bang?

People around the world discuss these questions everyday, and everyday at NASA, people work at finding the answers. The agency is unique in history as an enterprise devoted to broadening human knowledge across the scientific spectrum. NASA investigations range from the world of subatomic physics to the cosmic study of super novae and black holes . . . from charting Earth's ocean currents and winds to reducing the cost of air travel by 25 percent within 10 years.

NASA's programs are as immediately practical as improving wind shear avoidance for aircraft and as long range as sending astronauts to other planets. NASA scientists and engineers work at the future's threshold, on projects that often require knowledge we don't yet have, and technologies and materials still to be developed.

NASA is constantly looking for the ingenuity to meet these challenges and to maintain the strong technological base that keeps the United States the world leader in space science and aviation. Through the Graduate Student Researchers Program (GSRP), NASA offers bright, highly motivated graduate students an unmatched opportunity — the chance to work at the cutting edge of their fields, in concert with the nation's top scientists and engineers, in the most advanced facilities in the world.



Ahmad Nurriddin
GSRP National Program Manager

FROM THE NASA STRATEGIC PLAN

The NASA Team

The National Aeronautics and Space Administration is composed of a diverse group of men and women at our Headquarters and 10 Centers around the country, NASA does not accomplish its mission alone but in partnership with large and small contractors, members of the academic community, other Federal, State, and local agencies, and other space agencies from nations around the globe.

Together, these entities form a comprehensive, highly skilled team that is dedicated to providing high-quality, technologically superior products and services to its customers. NASA's highly skilled workforce, including scientists, engineers, technicians, and administrative and support professionals, and our world-class facilities represent the backbone of the Nation's civil research and development capabilities in aeronautics and space.

NASA Values

As individuals and as a team, we will strive to uphold these values of people, excellence, and integrity to implement this Plan.

People

Our greatest strength is our workforce. We aggressively build a team of highly qualified individuals that is representative, at all levels, of America's diversity. We foster a culture that is built on trust, respect, teamwork, communication, creativity, and empowerment in an environment that is free of unlawful discrimination and ensures equal opportunity for all.

Excellence

We are committed to demonstrating and promoting excellence and continually improving processes, products, and services to better satisfy our customers' needs and requirements. We utilize quality-focused leadership and management, as well as scientific, engineering, and technical excellence to provide our customers with highly valued products and services in the most cost-effective, timely, and safe manner.

Integrity

We preserve America's confidence and trust by ensuring that our missions are consistent with national goals, carefully conceived, and well executed. We deliver on our promises and are accountable for our performance. We are open and honest with one another and with our customers, and we cooperate within and across organizations to deliver the highest quality results. We are bold but prudent in confronting challenges and accepting risks. We work with integrity and are dedicated to fulfilling our vision in an environment in which adherence to fundamental ethical principles and compliance with related laws and regulations flourish.

STRATEGIC ENTERPRISES

The NASA Strategic Plan establishes a framework for making management decisions by separating the Agency's programs into four Strategic Enterprises through which we implement our mission and communicate with our external customers:

- Mission to Planet Earth (MTPE)
- Space Science
- Human Exploration and Development of Space (HEDS)
- Aeronautics and Space Transportation Technology (ASTT)

NASA's Strategic Enterprises identify at the most fundamental level what we do and for whom. They focus us on the ends, not the means, of our endeavors. Each of our Strategic Enterprises is analogous to a strategic business unit, employed by private-sector companies to focus on and respond to its customers' needs. Each Strategic Enterprise has a unique set of goals, objectives, and strategies that address the requirements of its primary external customers. However, each Enterprise must ensure synergy with and support of the Agency's common goals and the strategies of the other Enterprises.

Although NASA's broad mission is driven by the Space Act, the specific programs that are conducted within its Enterprises, and the priorities placed on them, are driven by the directives of the Administration and Congress. As such, the programmatic content of the Enterprises changes over time as we respond to shifts in customer needs as well as domestic and international policy priorities. The specific content of activities for the Enterprises is presented within their own Strategic Plans. The development of a balanced set of programs and Agency priorities among the Enterprises will lay the groundwork for the budget process.

MISSION TO PLANET EARTH

MISSION

NASA's Mission to Planet Earth (MTPE) is dedicated to understanding the total Earth system and the effects of natural and human-induced changes on the global environment. The MTPE Enterprise is pioneering the new discipline of Earth system science, with a near-term emphasis on global climate change. Space-based and *in situ* capabilities presently being used or developed yield new scientific understanding and practical benefits to the Nation.

To preserve and improve Earth's environment for future generations, governments around the world need policies based on the strongest possible scientific understanding. Commercial firms, natural resource managers, and educators rely on a dependable stream of this same new knowledge. The unique vantage point of space provides information about Earth's land, atmosphere, ice, oceans, and biota that is obtainable in no other way. In concert with the global research community, including the National Oceanic and Atmospheric Administration and the other agencies participating in the U.S. Global Change Research Program, the MTPE Enterprise is developing the understanding needed to support the complex environmental policy and economic investment decisions that lie ahead.

Mission to Planet Earth
Primary Center—Mission and Roles

Goddard Space Flight Center: Earth System Science

Jet Propulsion Laboratory: Instrument Technology

Langley Research Center: Atmospheric Science

Stennis Space Center: Commercial Remote Sensing

SPACE SCIENCE

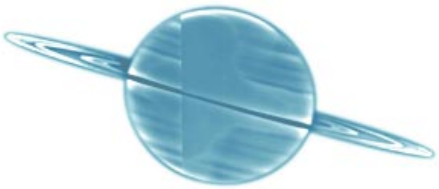
MISSION

Humans have a profound and distinguishing imperative to understand our origin, our existence, and our fate. For millennia, we have gazed at the sky, observed the motions of the Sun, Moon, planets, and stars, and wondered about the universe and the way we are connected to it. The Space Science Enterprise serves this human quest for knowledge. As it does so, it seeks to inspire our Nation and the world, to open young minds to broader perspectives on the future, and to bring home to every person on Earth the experience of exploring space.

The mission of the Space Science Enterprise is to solve mysteries of the universe, explore the solar system, discover planets around other stars, search for life beyond Earth, from origins to destiny, chart the evolution of the universe and understand its galaxies, stars, planets, and life.

In pursuing this mission, we develop, use, and transfer innovative space technologies that provide scientific and other returns to all of NASA's Enterprises, as well as globally competitive economic returns to the Nation. We also use our knowledge and discoveries to enhance science, mathematics, and technology education and the scientific and technological literacy of all Americans.

Space Science
Primary Center—Mission and Roles



Ames Research Center: Astrobiology

Goddard Space Flight Center: Physics and Astronomy

Jet Propulsion Laboratory: Planetary Science and Exploration

Johnson Space Center: Astro Materials

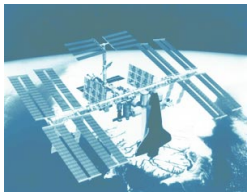
HUMAN EXPLORATION AND DEVELOPMENT OF SPACE

MISSION

We seek to bring the frontier of space fully within the sphere of human activity to build a better future for all humankind. Imagine new products based on space research, such as high-quality protein crystals to allow the design of new drugs for treating disease. Envision school children learning their lessons by telepresence instruction from the Moon. Imagine commerce flourishing in space, with solar power satellites, or a Martian powerplant to permit a permanent colony. These images are part of the Human Exploration and Development of Space (HEDS) Enterprise. The mission of the Enterprise is to open the space frontier by exploring, using, and enabling the development of space and to expand the human experience into the far reaches of space.

In exploring space, HEDS brings people and machines together to overcome challenges of distance, time, and environment. Robotic science missions survey and characterize other bodies as precursors to eventual human missions. The Space Shuttle and International Space Station (ISS) serve as research platforms to pave the way for sustained human presence in space through critical research on human adaptation. These programs also provide opportunities for research with applications on Earth. HEDS serves as a catalyst for commercial space development. We will employ breakthrough technologies to revolutionize human space flight.

Human Exploration and Development of Space
Primary Center—Mission and Roles



Ames Research Center: Astrobiology

Johnson Space Center: Human Exploration and Astro Materials

Kennedy Space Center: Space Launch

Marshall Space Flight Center: Space Transportation Systems and Microgravity Research

Stennis Space Center: Rocket Propulsion Testing

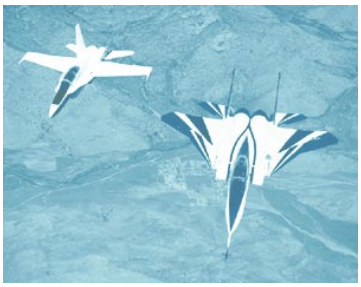
AERONAUTICS AND SPACE TRANSPORTATION TECHNOLOGY

MISSION

The mission of this Enterprise is to pioneer the identification, development, verification, transfer, application, and commercialization of high-payoff aeronautics and space transportation technologies. Through its research and technology accomplishments, it promotes economic growth and national security through a safe, efficient national aviation system and affordable, reliable space transportation. The plans and goals of this Enterprise directly support national policy in both aeronautics and space, documented in "Goals for a National Partnership in Aeronautics and Research Technology" and "National Space Transportation Policy." This Enterprise works in alliance with its aeronautics and space transportation customers, including U.S. industry, the university community, the Department of Defense, the Federal Aviation Administration, and other NASA Enterprises to ensure that national investments in aeronautics and space transportation technology are effectively defined and coordinated and that NASA's technology products and services add value, are timely, and have been developed to the level at which the customer can confidently make decisions regarding the application of those technologies.

The Enterprise also has agency responsibility for technology transfer and commercialization. This function is provided as an agency-wide service to ensure wide, rapid transfer of NASA developed technologies to U.S. industry for the social and economic benefit of all U.S. citizens.

Aeronautics and Space Transportation Technology
Primary Center—Mission and Roles



Ames Research Center: Aviation Operation Systems

Dryden Flight Research Center: Flight Research

Langley Research Center: Airframe Systems

Lewis Research Center: Aeropropulsion

Marshall Space Flight Center: Space Transportation Systems

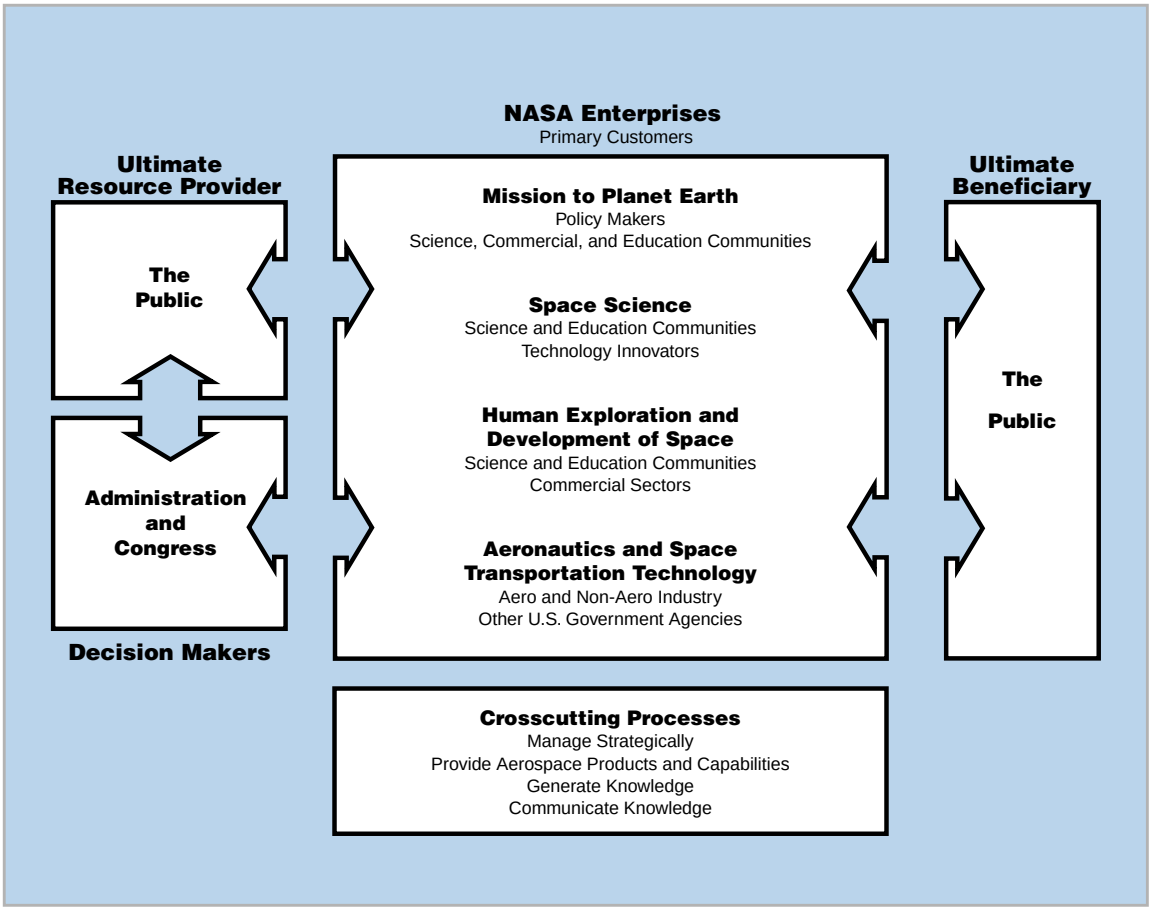
Stennis Space Center: Rocket Propulsion Testing

EXTERNAL CUSTOMERS

The NASA Strategic Plan is based on our commitment to satisfy our external customers and address changes in their requirements over time. Our performance and success in carrying out programs will be judged by our customers, not by ourselves. As a Government agency, we see the following groups as our external customers and stakeholders (see figure below):

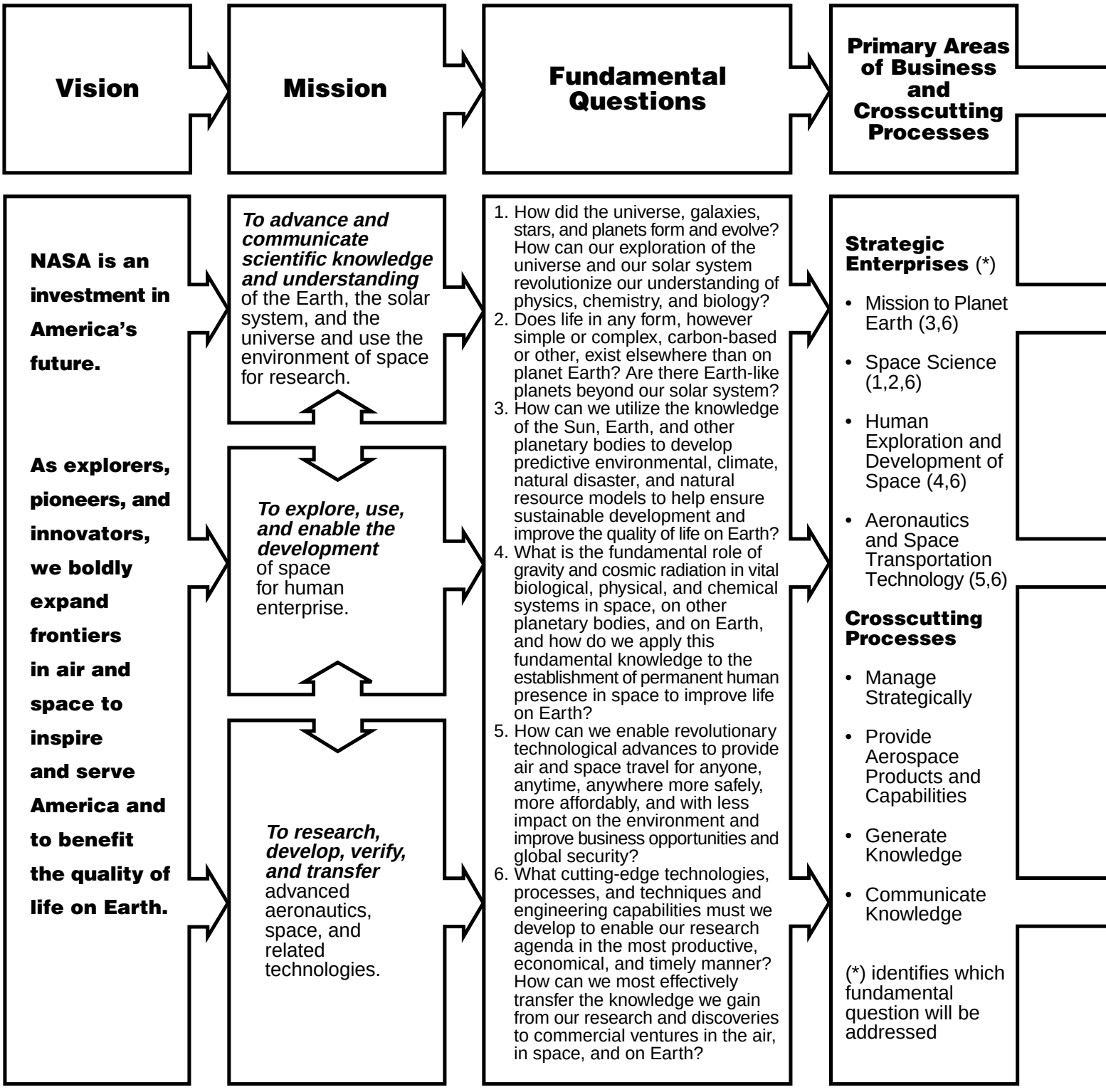
- The Administration and Congress, our primary stakeholders, provide us with the policy direction and financial resources to conduct the Nation's aeronautics and space programs.
- The science and education communities, aerospace and nonaerospace industries, Federal agencies, and other primary customers receive our products directly and use them for purposes that yield public benefit.
- The public is both our ultimate resource provider and the ultimate beneficiary of our products.

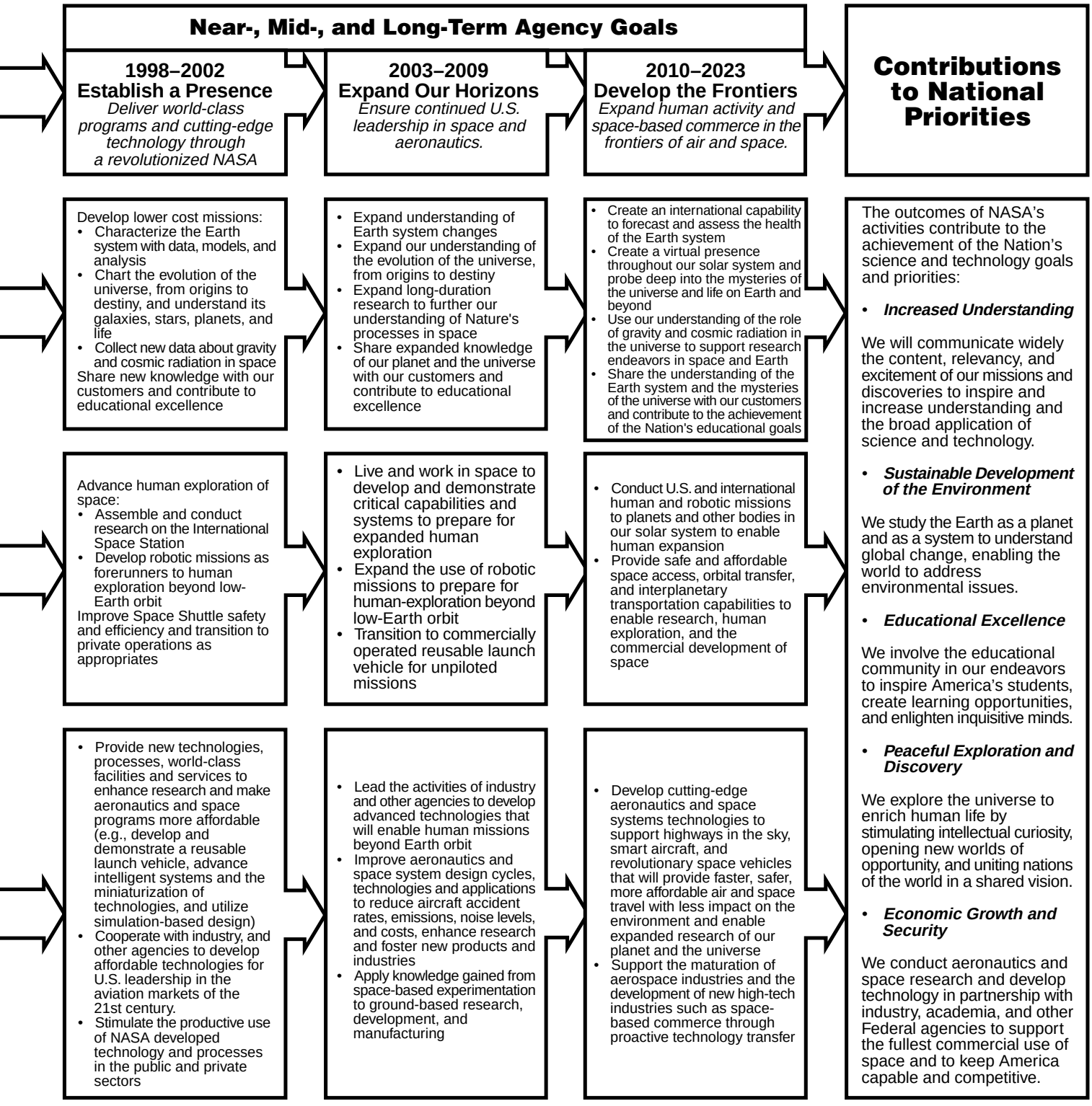
Stakeholders, Enterprises, Customers, and Beneficiaries



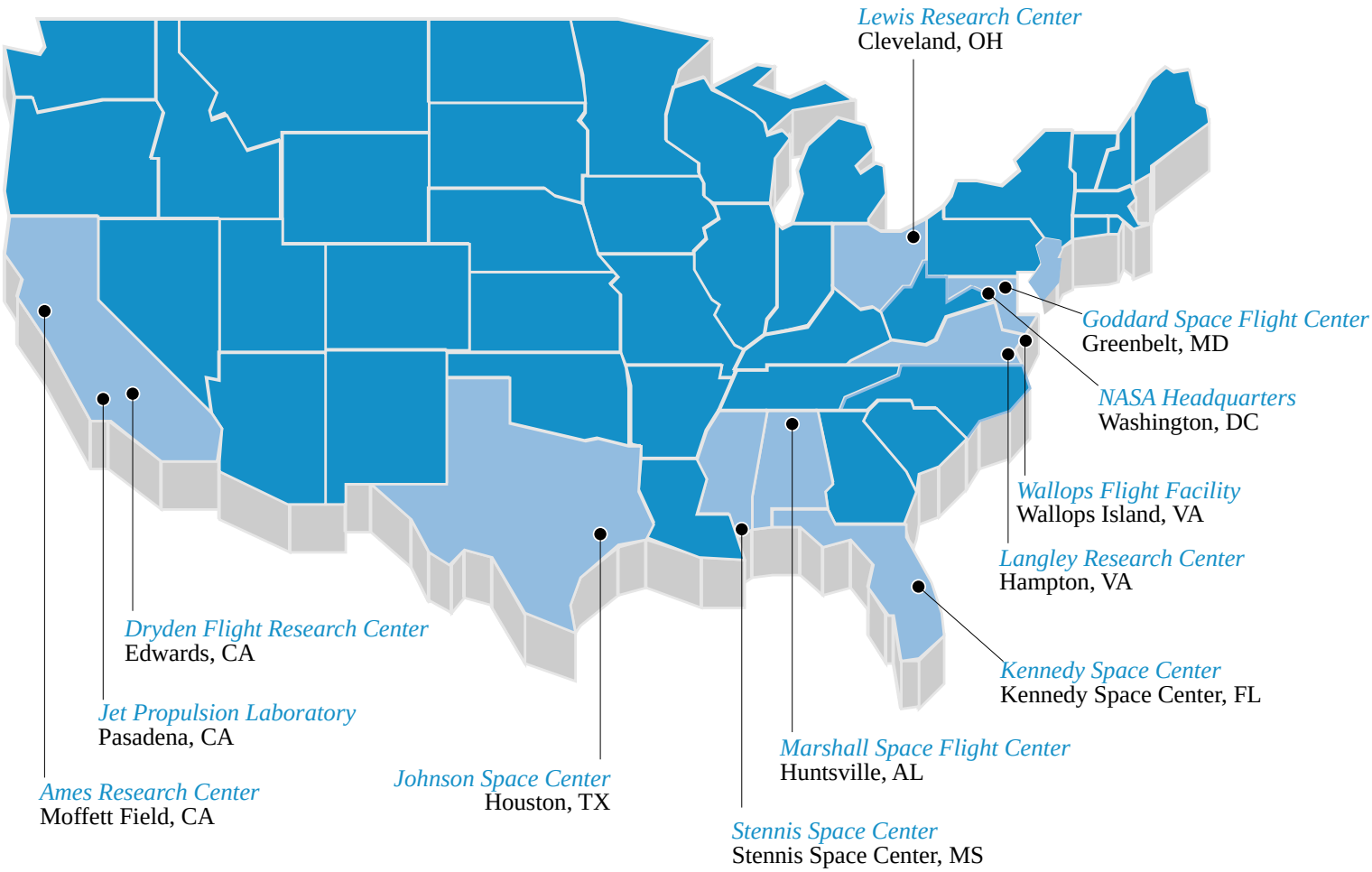
NASA's Strategic Roadmap to the Future

Vision, Mission, Questions, Goals, and Contributions to National Priorities



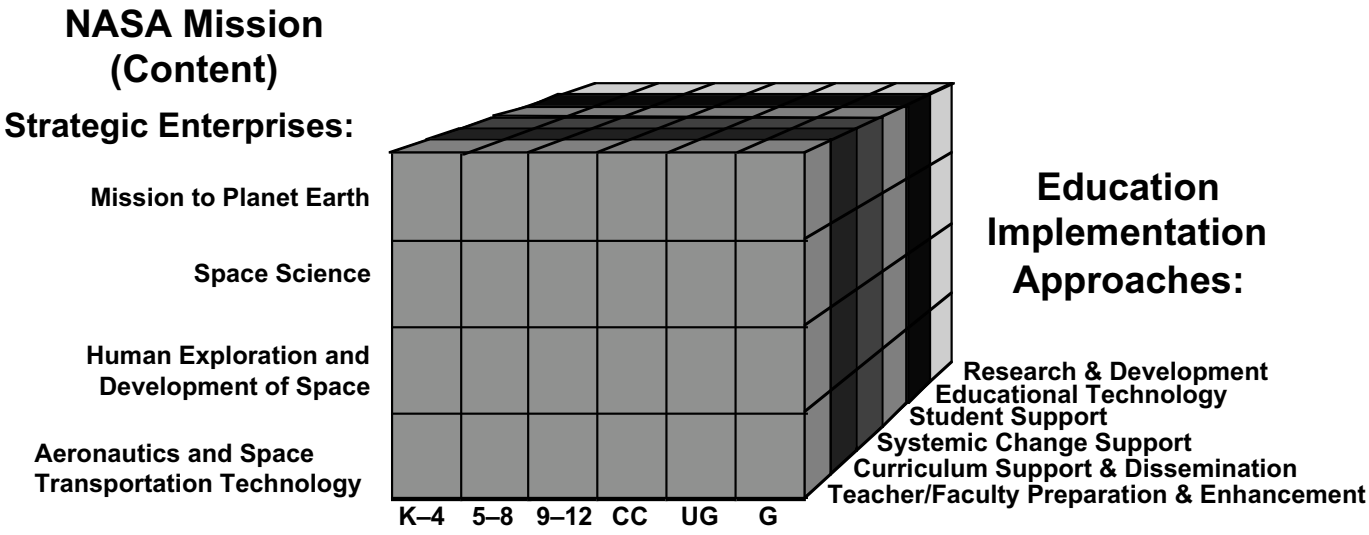

Near-, Mid-, and Long-Term Agency Goals
1998–2002
Establish a Presence
Deliver world-class programs and cutting-edge technology through a revolutionized NASA
2003–2009
Expand Our Horizons
Ensure continued U.S. leadership in space and aeronautics.
2010–2023
Develop the Frontiers
Expand human activity and space-based commerce in the frontiers of air and space.
Contributions to National Priorities
Develop lower cost missions:
• Characterize the Earth system with data, models, and analysis
• Chart the evolution of the universe, from origins to destiny, and understand its galaxies, stars, planets, and life
• Collect new data about gravity and cosmic radiation in space
Share new knowledge with our customers and contribute to educational excellence
• Expand understanding of Earth system changes
• Expand our understanding of the evolution of the universe, from origins to destiny
• Expand long-duration research to further our understanding of Nature's processes in space
• Share expanded knowledge of our planet and the universe with our customers and contribute to educational excellence
• Create an international capability to forecast and assess the health of the Earth system
• Create a virtual presence throughout our solar system and probe deep into the mysteries of the universe and life on Earth and beyond
• Use our understanding of the role of gravity and cosmic radiation in the universe to support research endeavors in space and Earth
• Share the understanding of the Earth system and the mysteries of the universe with our customers and contribute to the achievement of the Nation's educational goals
Advance human exploration of space:
• Assemble and conduct research on the International Space Station
• Develop robotic missions as forerunners to human exploration beyond low-Earth orbit
Improve Space Shuttle safety and efficiency and transition to private operations as appropriates
• Live and work in space to develop and demonstrate critical capabilities and systems to prepare for expanded human exploration
• Expand the use of robotic missions to prepare for human-exploration beyond low-Earth orbit
• Transition to commercially operated reusable launch vehicle for unpiloted missions
• Conduct U.S. and international human and robotic missions to planets and other bodies in our solar system to enable human expansion
• Provide safe and affordable space access, orbital transfer, and interplanetary transportation capabilities to enable research, human exploration, and the commercial development of space
• Provide new technologies, processes, world-class facilities and services to enhance research and make aeronautics and space programs more affordable (e.g., develop and demonstrate a reusable launch vehicle, advance intelligent systems and the miniaturization of technologies, and utilize simulation-based design)
• Cooperate with industry, and other agencies to develop affordable technologies for U.S. leadership in the aviation markets of the 21st century.
• Stimulate the productive use of NASA developed technology and processes in the public and private sectors
• Lead the activities of industry and other agencies to develop advanced technologies that will enable human missions beyond Earth orbit
• Improve aeronautics and space system design cycles, technologies and applications to reduce aircraft accident rates, emissions, noise levels, and costs, enhance research and foster new products and industries
• Apply knowledge gained from space-based experimentation to ground-based research, development, and manufacturing
• Develop cutting-edge aeronautics and space systems technologies to support highways in the sky, smart aircraft, and revolutionary space vehicles that will provide faster, safer, more affordable air and space travel with less impact on the environment and enable expanded research of our planet and the universe
• Support the maturation of aerospace industries and the development of new high-tech industries such as space-based commerce through proactive technology transfer
The outcomes of NASA's activities contribute to the achievement of the Nation's science and technology goals and priorities:
• Increased Understanding
We will communicate widely the content, relevancy, and excitement of our missions and discoveries to inspire and increase understanding and the broad application of science and technology.
• Sustainable Development of the Environment
We study the Earth as a planet and as a system to understand global change, enabling the world to address environmental issues.
• Educational Excellence
We involve the educational community in our endeavors to inspire America's students, create learning opportunities, and enlighten inquisitive minds.
• Peaceful Exploration and Discovery
We explore the universe to enrich human life by stimulating intellectual curiosity, opening new worlds of opportunity, and uniting nations of the world in a shared vision.
• Economic Growth and Security
We conduct aeronautics and space research and develop technology in partnership with industry, academia, and other Federal agencies to support the fullest commercial use of space and to keep America capable and competitive.

NASA Centers and Facilities



NASA EDUCATION FRAMEWORK

The Graduate Student Researchers Program, like all NASA education programs, is conducted in accord with the NASA Strategic Plan and the NASA Education Framework. These activities can be graphically explained by this figure which illustrates a three dimensional approach to serving the nation's education community. The figure includes three main components: NASA Mission, Education Community, and Education Implementation Approaches. On the left side of the figure are the four NASA Strategic Enterprises, the education levels are listed along the bottom, and the agency's implementation approaches are along the right side of the figure, defining the purpose of the educational activity.



Graduate Student Researchers Program

Program Background

In 1980, NASA initiated the Graduate Student Researchers Program. The purposes of GSRP are to cultivate additional research ties to the academic community and to support a culturally diverse group of students pursuing advanced degrees in science and engineering. NASA is composed of a diverse group of men and women at NASA Headquarters and the Agency's nine field centers and the Jet Propulsion Laboratory.

Administrative offices for the agency's four strategic enterprises are located at NASA Headquarters in Washington, DC, under the direction of NASA Associate Administrators. Headquarters offices are responsible for the management of NASA's research and development program, including determination of projects and programs, establishment of policies, evaluation of progress, and review and analysis of the aerospace program.

Awards

Fellowships are awarded for graduate study leading to research-based master's or doctoral degrees in the fields of science, mathematics, and engineering. Grants of up to $22,000, are awarded for one year and are renewable for a total of three years based on satisfactory academic advancement, research progress, and available funding. Approximately 400 graduate students are supported by this program each year. Students may apply prior to receiving their baccalaureate degree or at any time during their graduate career. An applicant must be sponsored by a faculty advisor or his/her graduate department chair. Awardees may not simultaneously accept any other Federal fellowships or traineeships. Under Section 178(a) of Title 38, U.S. Code, educational benefits from the Department of Veterans Affairs may be received at the same time. Upon completion of the research required by the fellowship program there is no formal obligation for service to the Federal government.

Each year approximately 160 new awardees are selected based on competitive evaluation of their proposal and academic qualifications. Usually sixty of the 160 new awards each year are sponsored by NASA Headquarters through the Office of Space Science (OSS) and the Office of Life and Microgravity Sciences and Applications (OLMSA) in the fields of structure/evolution of the universe, origins/planetary systems, solar system exploration, Sun-Earth connection, information systems, microgravity science and applications.

NASA's discipline scientists competitively evaluate students and their proposals based upon the students' academic qualifications, proposed research, and plan of study. Fellows selected by NASA Headquarters conduct research at their respective host institutions. The remaining awards are distributed through the nine NASA's Field Centers and the Jet Propulsion Laboratory, each of which has specific research programs and facilities. Fellows selected by Centers must spend some period of time in residence at the Center, taking advantage of the unique research facilities of the installation and working with Center personnel. The projected use of Center expertise and facilities is an important factor in the selection of Center fellows.

Submission of Proposal

All applicants must submit one original and five (5) copies of all materials by February 2, 1998, to the appropriate NASA facility from which consideration is being requested. Submissions should be addressed to the attention of the appropriate Program Administrator listed on page 20 of this brochure.

Applications will be reviewed and selections made in early May 1998. Proposed starting dates for new awards must be between July 1, and October 1, 1998. Proposals to NASA Headquarters Offices should indicate start dates that are either the 1st or 15th of the relative months.

Renewal Applications

Proposals for renewal are to be submitted to the appropriate center address by the February 2nd deadline. All applicants should submit an original and five (5) copies of all materials. The proposal for renewal must include a) a signed original proposal cover sheet; b) budget page; c) university certifications; d) a statement (approximately one to two pages)

by the student outlining his or her progress on the research or plan of study; e) transcript of the student's grades during the preceding year; and f) a one-page evaluation and recommendation for renewal signed by the faculty advisor must also be included. Proposals will not be renewed without this information. The starting date for renewals should be on the anniversary of the original grant.

Selection of Proposals

Graduate students are selected for participation in this program by NASA Headquarters, individual NASA Field Centers, or by the Jet Propulsion Laboratory. Selection is based on:

1. the quality of the proposed research or plan of study and its relevance to NASA programs;
2. student academic qualifications;
3. the ability of the student to accomplish the defined research; and:
   For Center Applicants;
4. the proposed utilization of Center research facilities.

Awards

Fellowships are made for a period of one year and may be renewed annually for a total of three years. Fellowship renewal is based on satisfactory progress as reflected in performance evaluations. Renewals must also be approved by the NASA Field Center Program Administrator and Technical Advisor at the appropriate NASA Field Center or NASA Headquarters.

Eligibility

All applicants must be full-time graduate students enrolled in an accredited U.S. college or university. Applicants must be citizens of the U.S. and may apply to the program prior to receiving their baccalaureate degrees or any time during their graduate work. Students who apply prior to acceptance in graduate school must submit a list of prospective schools and if selected must provide proof of acceptance prior to an award. All applications must be sponsored by a faculty advisor or the student's graduate department chair. An individual accepting this award may not concurrently receive other Federal fellowships or traineeships. African Americans, Native Americans, Mexican Americans, Puerto Ricans, Alaskan Natives, Native Pacific Islanders, women, and persons with disabilities are strongly urged to apply.

Equal Opportunity

No applicant shall be denied consideration or appointment as a NASA Graduate Student Researcher on the grounds of race, creed, color, national origin, age, sex or disability.

Equipment

The use of training grant funds for the purchase of equipment is prohibited.

Funding

The total annual award per graduate student cannot exceed $22,000. This amount includes a $16,000 (maximum) student stipend and an allowance of up to $6,000 consisting of $3,000 for student expenses and $3,000 for university expenses. The student allowance may be used to help defray tuition costs, purchase books and software, or to provide per diem and travel for the student. It may also be used to help defray living expenses during periods of Center residency.

The university allowance may also be used for tuition or to support research-related travel for the faculty advisor or the student. Alternative uses for this allowance may be requested but must be consistent with the intent of the program.

New grant applicants attending GSRP workshops/symposiums prior to their grant start date may be reimbursed for travel expenses.

Disposition of Unused Funds

If a student ends the GSRP earlier than anticipated, the student stipend is prorated and terminated. Any unused student/university allowances are returned to NASA. If a student withdraws within the first half of the award year, the award will be prorated and the remaining funds deobligated. Renewal applicants who have funds remaining from their previous year's budget may carry the remaining funds over into the following program year.

Graduate Student Researchers Program

Obligation to the Government

A student receiving support under the Graduate Student Researchers Program does not incur any formal obligation to the Government of the United States. The objectives of this program will be served best if the student actively pursues research, teaching, or employment in aeronautics, space science, or space technology after completion of graduate studies.

Replacement Students

If a student discontinues participation in the program after the first six months of a grant period, the university may nominate another student with similar achievement and research objectives to complete the remaining months of the current grant year. If the nominated replacement student is approved, an amendment to the grant will be issued. Replacement students must be approved by the appropriate NASA Grants Office.

Replacement students electing to apply to the GSRP for the following program year are subject to the evaluation and selection procedures administered to new applicants. Replacement students, selected as new applicants will be eligible for up to three full years of support, depending upon satisfactory progress and available funding.

Documentation required for nomination of replacement students must include: a) a written statement by the original student giving the date and reason for withdrawal from the program; b) a proposal cover sheet signed by the replacement student and faculty advisor; and c) a brief description of the student's research and educational background.

Foreign Travel

All foreign travel, charged to the grant, must have prior approval of the appropriate GSRP Administrator and NASA Grants Officer and must clearly be relevant to the research effort. For each foreign trip, the student or advisor must submit a written request on university letterhead stating the purpose, costs, travel dates, and the NASA fellowship number.

Internal Revenue Service

All questions concerning taxes should be directed to the Internal Revenue Service. Refer to IRS Publication 520 titled "Scholarships and Fellowships," and Publication 508 titled "Educational Expenses."

Inquiries

Questions concerning the preparation and submission of proposals and the administration of this program are to be directed to the appropriate Program Administrator. Policy questions should be directed to the National Program Manager.

Student Evaluation Forms

Students completing their last year in the program will be mailed an evaluation form 60 days prior to termination date. These forms must be completed and returned to the appropriate NASA Program Administrator. Students with approved no-cost extensions should return completed forms at the time of fellowship termination. If you do not receive the evaluation form, contact the GSRP Homepage on the Internet at: http://ednet.gsfc.nasa.gov/gsrp.

Final Administrative Report

It is the responsibility of the institution receiving a NASA fellowship grant to ensure the final report on the fellow's research and academic progress is submitted. This report is due no later than 90 days after the termination date of the award. The report must include: a) the degree granted; b) important results of the student experiences (e.g., thesis title, papers published other than thesis, presentations made, awards, honors); and c) employment or other future plans. This report should be submitted to the appropriate NASA Center or Program Office GSRP Administrator, and the relevant grants office. NASA Graduate Student Researchers fellowships are subject to the provisions of 14 CFR 1265, Government-wide Debarment and Suspension.

Preparation of Proposal

Proposal Requirements

Proposals for the GSRP must be written by the student. To ensure the preparation of a competitive proposal, students are strongly encouraged to collaborate with a faculty member and with a potential NASA Technical Advisor to identify a project. Students are advised to enlist the aid of their faculty advisor for guidance, review, and commentary on the written material prior to submission. All applicants must submit one original and five (5) copies of all materials by **February 2, 1998,** to each Center/ Program Office for which consideration is sought.

At least one (1) complete proposal package must contain original signatures. Proposals must be assembled in the following order:

1) Original Signed Proposal Cover Sheet
2) Abstract (100 words)
3) Budget
4) Description of Proposed Research and/or Plan of Study
5) Letter of Recommendation
6) Personnel
7) Certification
8) Planned Use of Facilities and Resources (Center Applications Only)

The original and all copies of proposals must be stapled. To facilitate the recycling of proposals after review, proposals should be submitted on plain, white paper only. Do not use cardboard stock, plastic covers, spiral binders, colored paper, etc.

1. Proposal Cover Sheet
The proposal cover sheet must be filled out and signed by the student, faculty advisor, and university official responsible for committing the institution for sponsored research. Proposals will not be funded without the required university approval signatures.

2. **Abstract**
Proposal abstracts should concisely detail the intended research and its relationship to the NASA mission. The abstract should not exceed 100 words.

3. Budget
Budget must include the following: (a) student stipend — up to $16,000 basic stipend for twelve months; (b) student allowance — $3,000. Cost estimates for tuition expenses and/or anticipated travel and living expenses for the student at a NASA facility; and (c) university allowance — $3,000. Cost estimates for travel of faculty advisor, or other expenses that relate to the student's research project. Student tuition may also be charged against this allowance. The budget must be prorated when the student anticipates less than a 12 month program tenure.

4. Description of Proposed Research and/or Plan of Study Students must prepare a typed, detailed research proposal (not to exceed five single-spaced pages). At a minimum, this critical document must contain a research plan, study objectives, schedule, methodology, key elements, and milestones.

The research proposal must be signed by the student and the advisor with an indication of a) extensive assistance from the advisor; b) moderate assistance of the advisor; or no assistance of the advisor.

5. Letter of Recommendation
The faculty advisor must prepare and sign a one page letter of recommendation on behalf of the student.

6. Personnel
The faculty advisor must submit a short biographical sketch that includes name, current position, title, department, university address, phone number, and principal publications. The student is required to submit a transcript of all university activities (graduate and undergraduate) along with a summary of special training, previous research projects, awards, scholarships, and significant accomplishments.

7. Certifications
All application packages must include university certifications to debarment and suspension and drug-free workplace.

8. Facilities and Resources (Center Applicants Only) Students competing for center awards must indicate the NASA facilities and resources to be used in support of the research and/or plan of study, including an estimate of any computer time required. Students are strongly encouraged to contact the appropriate NASA Technical Advisor to coordinate research activities.

Program Administration

The NASA Graduate Student Researchers Program (GSRP) is offered by the NASA Headquarters Education Division and is managed at the national level by:

Mr. Ahmad Nurriddin
National Program Manager
NASA Headquarters
Office of Human Resources
and Education
Code FE
Washington, DC 20546
Phone: (202) 358-1517
FAX: (202) 358-3048
Email: anurridd@hq.nasa.gov

NASA Headquarters Program Offices and each NASA Field Center and the Jet Propulsion Laboratory administers its own GSRP program under the direction of the following officials. Please direct proposals and inquiries to these individuals:

NASA Headquarters

Ms. Dolores Holland
Office of Space Science, Code S
NASA Headquarters
Washington, DC 20546-0001
Phone: (202) 358-0734
FAX: (202) 358-3092
Email:
dolores.holland@hq.nasa.gov

Ms. Debra Spears
Office of Life and Microgravity
Sciences and Applications
Code U
NASA Headquarters
Washington, DC 20546-0001
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FAX: (202) 358-4168
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Ames Research Center

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Hugh L. Dryden Flight Research Center

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Dryden Flight Research Center
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Goddard Space Flight Center

Dr. Gerald Soffen
NASA Goddard Space
Flight Center
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Jet Propulsion Laboratory

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Lyndon B. Johnson Space Center

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Program Administration

John F. Kennedy Space Center

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Langley Research Center

Mr. Roger A. Hathaway
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Lewis Research Center

Dr. Francis J. Montegani
NASA Lewis Research Center
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Cleveland, OH 44135
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FAX: (216) 433-3687
E-mail: fjm@lerc.nasa.gov

George C. Marshall Space Flight Center

Dr. James F. Dowdy, Jr.
Ms. Tammy B. Rowan
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John C. Stennis Space Center

Dr. Armond Joyce
University Programs Officer
John C. Stennis Space Center
Stennis Space Center, MS 39529
Phone: (228) 688-3830
FAX: (228) 688-7499
E-mail:
Armond.T.Joyce@ssc.nasa.gov

Disciplines at NASA Centers

The following set of charts depict awardee disciplines for the 1996 program by NASA field center and Headquarters program. This is not an exclusive indication of the disciplines supported but a quick reference to the array of academic areas that are associated with each program component.

Ames Research Center	
Aeronautical Engineering	Chemistry
Astronautical Engineering	Computer Sciences
Astronomy	Electrical Engineering
Atmospheric Sciences	Life Sciences
Biological Sciences	Mechanical Engineering
Chemical Engineering	

Dryden Flight Research Center	
Astronomy	Mechanical Engineering
Computer Sciences	

Goddard Space Flight Center	
Aeronautical Engineering	Geological Sciences
Astronomy	Mechanical Engineering
Atmospheric Sciences	Medical Sciences
Computer Sciences	Oceanography
Electrical Engineering	Physics

Headquarters Code S	
Aeronautical Engineering	Computer Sciences
Astronautical Engineering	Electrical Engineering
Astronomy	Geological Sciences
Atmospheric Sciences	Physics
Biological Sciences	
Chemistry	

Disciplines at NASA Centers

Headquarters Code U	
Aeronautical Engineering	Mathematics
Agricultural Sciences	Mechanical Engineering
Biological Engineering	Medical Sciences
Biological Sciences	Metallurgy, Materials
Chemical Engineering	Physics
Chemistry	
Civil Engineering	
Life Sciences	

Headquarters Code Y	
Aeronautical	Geological Sciences
Agricultural Sciences	Metallurgy, Materials
Atmospheric Sciences	Oceanography
Biological Sciences	Physics
Chemistry	Social Science
Electrical	

Jet Propulsion Laboratory	
Astronautical Engineering	Electrical Engineering
Astronomy	Geological Sciences
Chemistry	Physics
Computer Sciences	

Johnson Space Center	
Aeronautical Engineering	Electrical Engineering
Agricultural Sciences	Geological Sciences
Biological Sciences	Mechanical Engineering
Chemical Engineering	
Computer Sciences	

Kennedy Space Center	
Agricultural Sciences	Civil Engineering
Biological Sciences	Mathematics
Chemistry	Mechanical Engineering

Disciplines at NASA Centers

Langley Research Center	
Aeronautical Engineering	Electrical Engineering
Astronautical Engineering	Environmental Sciences
Astronomy	Mechanical Engineering
Biological Engineering	Metallurgy, Materials
Chemical Engineering	Physics
Chemistry	Psychology
Computer Sciences	Social Aspects

Lewis Research Center	
Aeronautical Engineering	Electrical Engineering
Astronautical Engineering	Mechanical Engineering
Chemical Engineering	Metallurgy, Materials
Chemistry	Physics
Computer Sciences	

Marshall Space Flight Center	
Aeronautical Engineering	Math/Computers
Astronomy	Mechanical Engineering
Chemistry	Metallurgy, Materials
Electrical Engineering	Physics

Stennis Space Center	
Astronautical Engineering	Environmental Sciences
Chemical Engineering	Mathematics
Civil Engineering	Mechanical Engineering
Computer Sciences	Oceanography
Electrical Engineering	Physics

Office of Space Science

NASA Headquarters

The NASA Headquarters Office of Space Science (OSS) supports basic and applied research in space science. The OSS research program includes the development of major space flight missions such as the Advanced X-Ray Astronomical Facility and the Cassini Mission to Saturn, complementary laboratory research and analysis of data from prior missions, and theoretical studies.

Program Administrator:
Ms. Dolores Holland
Office of Space Science
Code S
National Aeronautics and Space Administration
Washington, DC 20546-0001
Phone (202) 358-0734
Fax (202) 358-3092
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dolores.holland@hq.nasa.gov

Mail Office of Space Science proposals to:
Graduate Student Researchers Program-HQ OSS
Jorge Scientific Corporation
400 Virginia Avenue, SW #700
Washington, DC 20024

Within the Office of Space Science, activities are organized into four major theme areas. A brief description of these themes follows:

Structure and Evolution of the Universe — *addresses cosmology, large scale structure of the universe, evolution of stars and galaxies, including the Milky Way and objects with extreme physical conditions. Questions of interest are: What is the universe? How did it come into being? How does it work? What is its ultimate fate?*

Astronomical Search for Origins and Planetary Systems — *addresses the origins of galaxies, stars, protoplanatary disks, extra-solar planetary systems, Earth-like planets, and the origin of life. Questions of interest are: How were galaxies born? How do stars and solar systems form? Are there other Earth-like planets?*

Solar System Exploration — *addresses scientific activities that pertain to the solar system, including comets, and major and minor planets. Questions of interest are: What is the origin of the Sun, the Earth, and the planets, and how did they evolve? Are there worlds around other stars? What are the ultimate fates of planetary systems? What threat is posed by the potential for collisions with Earth-approaching objects?*

The Sun-Earth Connection — *addresses the sphere of influence of the Sun on the Earth environment. Questions of interest are: What causes solar variability? How does the sun and its variability affect the Earth and other planets?*

Structure and Evolution of the Universe

This theme encompasses research in the areas of cosmology, the evolution of stars and galaxies, large-scale structure of the universe, the end products of stellar evolution such as supernovae and their remnants, neutron stars and black holes, the unsolved mysteries of dark matter and gamma-ray bursts, and the physical laws governing the universe. It includes high energy astrophysics (x-ray and gamma ray astronomy),galactic cosmic rays (also referred to as particle astrophysics), extreme ultraviolet astronomy, submillimeter and radio astronomy from space, and gravitation and relativity studies in space. It covers space observations in the electromagnetic spectrum roughly shortward of 912 angstroms and longward of 100 microns. Emphasis is placed on the development and implementation of a multiwavelength program of space-based and suborbital missions (airborne, sounding rockets, balloons). Investigations that support instrumentation development relevant to future missions in the above areas, the analysis of data from ongoing and past missions, and laboratory and

Office of Space Science

theoretical investigations that support the interpretation of relevant space-based observations are invited.

Astronomical Search for Origins and Planetary Systems

Research in origins is directed toward a greater understanding of the origin of galaxies, stars, solar systems, and life. Emphasis is placed on the development and implementation of a multiwavelength program of space-based and suborbital missions (airborne, sounding rockets, balloons). Programs that support instrumentation development relevant to future missions, the analysis of data from ongoing and past missions, and on laboratory and theoretical investigations that aid in the interpretation of space-based observations.

Solar System Exploration

Solar system research focuses on the origin, evolution, and current state of the various bodies in the solar system, including their interiors, surfaces, and atmospheres and the origin, evolution, and distribution of life beyond the Earth in the solar system. Research exploits analysis of data collected by ground-based and satellite borne instruments, laboratory experiments, and theoretical modeling. Relevant research topics include studies of the planets, rings, moons, asteroids, and comets; analysis of lunar, meteorite, and cosmic dust samples; and analysis of data returned from spacecraft. Areas of research interest include planetary geology and geophysics, materials and geochemistry, exobiology, planetary atmospheres, planetary astronomy, and planetary system science.

The Sun-Earth Connection

Research in the Sun-Earth Connections theme focuses on investigations of the Sun, both as a nearby star and as a source of variable outputs of solar wind, energetic particles, and electromagnetic radiations with influence on the Earth and its space environment, on planetary and cometary magnetospheres, and on the heliosphere, and on the local interstellar medium. The program involves investigations of the origin, evolution, and physics of plasmas, electromagnetic fields, and energetic particles in space. Studies of the terrestrial space environment include investigations of the coupling between the variable Sun and the Earth's magnetosphere, ionosphere, thermosphere, and mesophere. Measurements are made from balloons, rockets, satellites, and deep space probes. Theory and computer simulations are also supported.

Solar activity and the consequential effects of today's technological systems is on the rise from the present solar cycle minimum toward solar maximum in 2000–2001. A unique fleet of spacecraft from the International Solar Terrestrial Physics program are poised to record and track, and research will understand, these Earth-impacting events.

Office of Space Science opportunities offered in Information Systems, are as follows:

Information Systems

Information Systems research focuses on providing new capabilities for data archives and directories, computer networking, and high-performance computing in support of space science. The program includes development of generic tools and capabilities, testbed efforts to demonstrate and evaluate advanced technologies for NASA, technology demonstrations, and research efforts in areas such as graphics and visualization, algorithms, data storage technologies, and access methods applicable to the space science disciplines and research themes.

Office of Life and Microgravity Sciences and Applications

NASA Headquarters

Program Administrator:

Ms. Debra Spears
Office of Life and
Microgravity Sciences
and Applications
Code UP
NASA Headquarters
Washington, DC 20546-0001
(202) 358-0123

Mail OLMSA proposals (including express mail, commercial delivery, or courier) to:

Graduate Student
Researchers Program
Attn: Ms. Kathleen Wilson
Information Dynamics, Inc.
300 D Street, SW
Suite 801
Washington, DC 20024

MICROGRAVITY RESEARCH

The Microgravity Research Division (MRD) conducts a program of physical sciences and process research within the Human Exploration and Development of Space strategic enterprise of NASA. This research is managed within five disciplines: Biotechnology, Combustion Science, Fluid Physics, Fundamental Physics, and Materials Science. Research sponsored by MRD uses the unique attributes of the space environment to advance scientific knowledge and technology, and uses advances in scientific knowledge to better understand the performance of technologies in the unique environment of space. The program includes ground-based research, predominantly conducted within colleges and universities, advanced technology development activities, and flight investigations conducted aboard the Space Shuttle, the Mir space station, and, beginning in 1999, aboard the International Space Station.

LIFE SCIENCES

The Life Sciences Division involves multidisciplinary research areas in the biomedical and biological sciences. Research focuses on: gravitational biology, space physiology, and counter-measures; radiation health; human factors; and advanced human support technologies. The program includes ground-based research and technology development and flight investigations conducted aboard the Space Shuttle, the Mir space station and beginning in 1999, aboard the International Space Station.

Ames Research Center

Aerial view of Ames Research Center

Mission

Ames is the NASA designated Center of Excellence for Information Technology and has Agency lead mission responsibility for Aviation Operations Systems and Astrobiology. Ames Research Center also has Lead Center program roles in Aviation System Capacity, Rotorcraft Technology, High Performance Computing and Communications, Gravitational Biology and Ecology, Supercomputer Consolidation, Simulators and Aeronautics Computers. Ames is home to three national wind tunnel complexes, including the world's largest; several advanced flight simulators; a variety of supercomputers, including some of the world's fastest; a suite of centrifuges that serve as a national resource; and several unique aircraft used for aeronautical flight research and as flying scientific laboratories. Ames has a wide variety of other facilities for life, earth and space science research.

Ames Research Center

Moffett Field, CA

The Ames Research Center conducts research activities, technology programs, and flight projects that advance the nation's capabilities in civilian military aeronautics, space sciences, and space applications. This diverse program at Ames is organized into aeronautics, information systems, and space.

In preparing a proposal for a fellowship at Ames Research Center, prior collaboration with an Ames researcher is mandatory. A suggested point of contact is listed with each research topic for which a student may apply.

Program Administrator:

Ms. Marilyn Jackson
Mail Stop 241-3
NASA Ames Research Center
Moffett Field, CA 94035
(650) 604-6937
Email address:
mjackson@mail.arc.nasa.gov

Ms. Meredith Moore
Mail Stop 241-3
NASA Ames Research Center
Moffett Field, CA 94035
(650) 604-5624
Email address:
mmoore@mail.arc.nasa.gov

AERONAUTICS

In aeronautics, Ames concentrates on rotorcraft and powered lift aircraft technology, fluid mechanics, experimental aerodynamics, flight simulation, flight systems research, advanced air traffic management system, and human factors.

George Kidwell
(650) 604-5060

Experimental Aerodynamics — Low-speed testing in the 12x24-, 24x37-, and 2x3-meter wind tunnels. Development of computational/empirical prediction methods for powered lift and conventional lift configurations. Prediction and analysis of acoustic characteristics of aircraft configurations and wind tunnel facilities. Development and application of nonintrusive measurement techniques.

Larry Olson
(650) 604-6681

Air Traffic Management — Conflict detection and resolution, air traffic control automation, air traffic information management and display.

Heinz Erzberger
(650) 604-5425

High Performance Computing and Communications (HPCC)/Computational Aerosciences Project — Current advances in high performance computing are coming from novel computer architectures such as parallel processors, vector processors, and heterogeneous networks of computers. The suitability of these architectures to solving problems of interest to NASA and the development of new architectures that efficiently solve these problems is the objective of this research. Of particular interest is the investigation of architectures to solve problems arising in computational fluid dynamics as governed by the Navier-Stokes equations. These investigations could include software issues (e.g. tailored environments or multi-disciplinary support) as well as hardware issues because the ultimate goal is to provide the researcher at Ames with improved computational resources. Current computational resources include CRAY C90's and IBM SP2, SGI Origin 2000 as well as a network with powerful workstations and superminis.

Catherine Schulbach
(650) 604-3180

Rotorcraft Controls and Displays — Design and evaluation of human-centered cockpit technologies for rotorcraft, flight control theory, control system design procedures and design tools, cockpit display and symbology design principles, guidance and navigation, vehicle and human performance modeling, simulation and flight investigations and demonstrations.

William Hindson
(650) 604-1106

Ames Research Center

Scientific Visualization and Interactive Computer Graphics — This research is aimed at the creation of a highly interactive and visual environment for scientists who are developing computer simulations of physics or who are required to analyze large 3-D data–sets. Current research is being done using Silicon Graphics Workstations connected to supercomputers.

Tom Lasinski
(650) 604-4405

Computational Fluid Dynamics — Theoretical research in fluid dynamics using the Euler and the Navier-Stokes equations, both compressible and incompressible. Includes research on basis equation formulations, algorithm development, and code efficiency, as well as the physics of laminar and turbulent flow fields.

Thomas H. Pulliam
(650) 604-6417

Turbulence Physics — Study of the fundamental physics of turbulent and transitional flows through numerical simulations and experiments. Studies include developing numerical algorithms suitable for direct and large-eddy simulations of turbulent flows, developing tools for analyzing computer-generated, databases, developing turbulence models for engineering applications, and performing experiments to understand flow physics and support turbulence model validation.

Nagi Mansour
(650) 604-6420

Aeronautical Fluid Mechanics — Research areas under investigation include dynamic stall control, drag reduction of airfoils and wings, and the control of supersonic transition. Experimental, computational, and theoretical tools are developed and used in both basic and applied studies.

Sanford Davis
(650) 604-4197

Rotorcraft Aeromechanics — Experimental and theoretical research programs to improve performance, vibration, and noise of advanced rotorcraft. Studies include basic investigations of the aerodynamics, dynamics, and acoustics of rotor systems for helicopters, tilt rotors, and other advanced configurations. Experiments are performed in the Ames 7 x 10-foot wind tunnel and in the National Full-Scale Aerodynamics Complex, including the 40 x 80-foot wind tunnel.

William Warmbrodt
(650) 604-5642

Computer Vision — Computer vision and image understanding techniques are being applied to the navigation of rotorcraft and aircraft during low-altitude flight, landing and taxing. The techniques are quite general and can be used in the autonomous guidance of other types of vehicles.

Banavar Sridhar
(650) 604-5450

Human Factors — Crew performance, aviation safety, aircraft operating systems advanced spatial displays and instruments, virtual environments, high-fidelity simulation-based human performance assessment, operator interfaces to intelligent systems and advanced automation.

Mike Shafto
(650) 604-6170

INFORMATION SYSTEMS

As the Center of Excellence for Information Technology (COE-IT), Ames' primary mission is to provide strategic research focus and Agency-level coordination of NASA's investment in advanced information technology. Ames' role is to pioneer and lead the research, development, and implementation of information technologies to support NASA's Aeronautics and Space Enterprises and missions. In support of the four NASA Strategic Enterprises — Aeronautics, Space Science, Human Exploration and Development of Space, and Mission to Planet Earth — five information technology focus areas have been identified: Integrated Design Systems; Large-Scale Information Management and Simulation; Aviation Operations; Space Systems Operations; and Autonomous Systems for Space Flight.

Neuroengineering — Basic and applied research is conducted in intelligent computational systems technology for Aeronautics and Space Missions. Activities address soft computing technologies for real-time performance and

adaptability in dynamically changing environments. Current research programs include real-time reconfiguration control for damaged air and spacecraft, early design augmentation and performance estimation using neural, fuzzy, and genetic algorithms, virtual reality simulation of early design prototypes, real-time signal and pattern recognition for fault diagnosis, and evaluation of neural and fuzzy set processing architectures. Emphasis is placed on new methods for rapid gradient search and system identification, integration of soft computing technology with graphic simulation, and new analysis tools to verify adaptive algorithm performance, robustness, convergence, and certification.

Chuck Jorgensen
(650) 604-6725

Artificial Intelligence — Basic and applied research is conducted in the framework of aerospace domains including space transportation, space science, and aeronautics. Three research areas are emphasized: Planning (including both goal- and resource-driven approaches); machine learning (entire spectrum from empirical to knowledge-intensive); and the design of and reasoning about large-scale physical systems (including work in knowledge acquisition, knowledge base maintenance, and all applications to the design process).

Brian Williams
(650) 604-4776

Applied Information Technology — As an expert center for computer security and workgroup/workflow, Ames will play a considerable role in developing and integrating the "Office of the Future" into the NASA environment. Taking advanced technologies from Ames' Information Technology Center of Excellence and from industry, engineers and computer scientists will adapt these concepts to desktops throughout the Agency.

Scott Santiago
(650) 604-5015

SPACE

The Space Directorate at Ames manages activities in research and technology development in support of NASA's space programs. Work is done in Space Sciences, Life Sciences and Earth Sciences; in addition, programs are conducted in Space Technology and in Space Flight Projects.

Space Technology — The work of Space Technology includes both research and development of devices and systems that will be needed on future space missions. Research areas range from the application of computer capabilities simulating the physical and chemical environment, to the direct collection of physical and chemical data. Areas of technology development range from thermal protection during atmosphere entry to methods of rapid and complete organic waste oxidation.

Aerothermodynamics — Provides aerothermodynamic flow-field computational capability to analyze and design advanced space transportation concepts. Also provides the analytical and turbulence chemistry models required to compute the viscous/finite-rate flow field and to predict radiation heating to conceptual aero-assisted orbital vehicles.

Paul Wercinski
(650) 604-3157

Aerothermal Materials and Structures — Develops lightweight reusable ceramics and carbon-carbon Thermal Protection Systems (TPS) for transient, high-velocity atmospheric penetration and develops expendable TPS for planetary probes.

Daniel Rasky
(650) 604-1098

Computational Chemistry — Application of molecular structure, molecular dynamics and molecular modeling techniques to a wide range of problems of NASA interest. Current research activities are focused on nanotechnology, device modeling high-energy density materials, combustion research, polymers, astrophysics, aerothermodynamics, and atmospheric chemistry. Specifically, we are interested in computing accurate thermodynamic properties, vibrational frequencies and intensities, molecular line strengths, reaction rates, electron-molecule cross sections, transport properties and spectroscopic constants. We are also interested in porting and extending code for current and next generation parallel architectures.

Ames Research Center

Stephen R. Langhoff
(650) 604-6213

Applied Computational Fluid Dynamics — This area deals with the development of new computational methodology involving aerodynamic and/or fluid dynamic application associated with incompressible, subsonic, transonic, speeds. Computer codes are constructed and evaluated for applications associated with aircraft or aircraft component aerodynamics, rotorcraft aerodynamics, high-angle-of-attack flows, unsteady flows, and flows with aeroelastic effects.

William R. Van Dalsem
(650) 604-4469

Hypersonics — This area deals with the development of new computational methodology involving aerodynamic and/or fluid dynamic applications associated with hypersonic flight speeds. The physical aspects of this flight regime require emphasis on algorithms/codes with accurate heat transfer prediction capabilities, strong shock capturing abilities and chemical equilibrium and non-equilibrium models for air and other planetary atmospheres.

John A. Cavolowsky
(650) 604-4434

Life Support — Research is conducted in the broad area of regenerative life support for space: the conservation and re-use of materials consumed by space crews. Issues of interest include the use of physical and chemical devices for air regeneration, water purification, waste management and oxidation and atmosphere contaminant control. Also of interest are systems control, systems modeling and simulation and the potential role of biological systems in life support supplementation. Mechanical systems of interest include some aspects of space suit design.

Mark Kliss
(650) 604-3203

SPACE SCIENCES

In space science, Ames concentrates on research directed at enhancing understanding of the origins, evolution, current state of the universe, the solar system, the Earth, and life. Principal efforts focus on a multidisciplinary approach to research activities in space science and life science. Particular emphasis in space science is placed on infrared science and climatology, Earth airborne sciences, and the development and application of selected flight projects and areas of space technology relevant to those research needs.

Infrared Astronomy Projects and Technology Development — Current research is focused on the integration of the design tools to allow full system simulation prior to SOFIA operation. The technology tasks include IR detectors and cryogenics. Multi-element IR detector arrays are developed and characterized for space astronomy. Advanced efficiency cooling techniques are developed for space.

Chris Wiltsee
(650) 604-5917

Theoretical Astrophysics — Research is being conducted on star formation, circumstellar disks, the physics and chemistry of the interstellar medium, and the formation and dynamical evolution of galaxies. Theoretical models involve the application of computational techniques to problems in astrophysical gasdynamics, radiative transfer, and many-body systems.

Pat Cassen
(650) 604-5597

David Hollenbach
(650) 604-4164

Planetary Science — Research in this area includes atmospheric, chemical, radiative, and dynamic models, remote sensing of planetary ring dynamics.

Pat Cassen
(650) 604-5597

Jeff Cuzzi
(650) 604-6343

Solar System Exploration — Solar system exploration research defines flight experiments and related data bases and develops analytical concepts and prototype flight instrumentation for the extraterrestrial study of exobiology (history of the biogenic elements, chemical evolution, and origin and early evolution of life). Particular emphasis is placed on the biogenic elements (C, H, N, O, P, S) and their compounds as they relate to the composition and physical

characteristics of the various bodies and materials of the solar system, such as cometary nuclei and comae and planetary atmospheres and surfaces. Experiment and instrument definition studies for Mars, interplanetary dust particles, and comet sample return are currently being conducted.

Glenn Carle
(650) 604-5765

Exobiology — Interdisciplinary research in planetary biology is aimed at understanding the factors in cosmic, solar system, and planetary development that have influenced the origin, distribution, and evolution of life in the universe and the course of interaction between biota and earth's surface environments.

Sherwood Chang
(650) 604-5733

LIFE SCIENCES

In life sciences, Ames concentrates on biomedicine (the effects of the space environment on man and other organisms); extraterrestrial research; and biosystems (the ability to support man in the space environment).

Space Biology — Space biology research uses the space environment, particularly weightlessness, and ground-based space flight simulations to investigate basic scientific questions about the role of gravity in present-day terrestrial biology. The research is divided into the disciplinary areas of biological adaptation, gravity sensing, and developmental biology. Experiments are carried out at the subcellular, cellular, tissue, organ, and system levels in differing organisms of the five kingdoms of life.

Ruth Globus
(650) 604-5247

Neurosciences — Research in neuro-sciences examines how the nervous system adapts to environmental conditions encountered in space, how adaptive processes can be facilitated, and how human productivity and reliability can be enhanced. To elucidate mechanisms underlying adaptation, neurosciences research includes neurochemistry, neuroanatomy, neurophysiology, vestibular physiology, psychophysiology, and experimental and physiological psychology. State-of-the-art facilities include: human and animal centrifuges, linear motion devices, an animal care facility, a human bed-rest facility, and NASA's Vestibular Research Facility.

Mal Cohen
(650) 604-6441

Space Physiology — Multidisciplinary research in space physiology emphasizes the effects of hypergravity, gravity and microgravity on cardiovascular, musculoskeletal, and regulatory systems of humans and animals. Actual microgravity and ground-based models of simulated micro-gravity are used to investigate basic mechanisms of adaptation to space and readaptation to Earth. Physiological, biomechanical, cellular, and biochemical factors are also studied to develop appropriate countermeasures for maintaining health, well-being, and performance of humans in space.

Alan Hargens
(650) 604-5746

EARTH SYSTEM SCIENCE

In Earth System Science, the focus at Ames is to perform and lead research within the disciplines of atmospheric and ecosystem science, with particular emphasis on how the biosphere and atmosphere interact to influence the evolution of the global system on all time scales.

Atmospheric Physics — Research in this area advances the scientific knowlegde and understanding of the physical processes that determine the behavior of the atmosphere on Earth and other solar system bodies. Experimental and theoretical research are conducted in the areas of aerosol and cloud microphysics, atmospheric modeling, atmospheric radiation, and high resolution infarred spectroscopy with the main focus on current environment and climatic issues. By utilizing cutting-edge and information technologies, and unique instrumentation research techniques are developed to implement these research goals.

Warren Gore
(650) 604-5533

Ames Research Center

Ecosystem Science and Technology — Interdisciplinary research in ecosystem science and technology looks at the role of life in modulating the complex cycling of materials and energy throughout the biosphere. Intact ecosystems, with particular emphasis on temperate and tropical forests, are examined by remote sensing from aircraft and spacecraft and by field site visits, with subsequent laboratory and computer analysis of the data gathered.

David Peterson
(650) 604-5899

Earth Atmospheric Chemistry and Dynamics — Research in this area includes the development of models and the use of airborne platforms and spacecraft to study chemical and transport processes that determine atmospheric composition, dynamics, and climate. These processes include the effects of natural and man-made perturbations.

Phil Russell
(650) 604-5404

Ecosystem Science — Research in this area is directed to advanced understanding of the physical and chemical processes of biogeochemical cycling and ecosystem dynamics of terrestrial and aquatic ecosystems through the utilization of aerospace technology.

David Peterson
(650) 604-5899

Dryden Flight Research Center

"Boomers" view of Dryden's SR-71A

Mission

- Conduct safe and timely flight research and aircraft operations for current and future aerospace vehicles.
- Conduct atmospheric flight operations for NASA science platform aircraft.
- Support development and operations for Shuttle and future access-to-space vehicles.
- Enhance competitiveness to US aerospace industry.

Hugh L. Dryden Flight Research Center

Edwards, CA

The Dryden Flight Research Center program includes most engineering disciplines in aeronautics with emphasis on flight systems integration and flight dynamics. The following descriptions identify the current activities relevant to the Dryden program for which qualified students may apply.

Program Administrator:

Dr. Kajal K. Gupta
Dryden Flight Research Center
P.O. Box 273
Edwards, CA 93523
Phone (805) 258-3710

Advanced Digital Flight Control — Modeling, simulation, and flight test of distributed control systems. Design criteria and methods for unconventional vehicles, including decoupling of asymmetrical airplanes and stabilization of highly unstable airframes.

Robert Clarke
(805) 258-3799

Flight Systems — Engineering aspects of the formulation, design, development, fabrication, evaluation, and calibration of flight control, avionic, and instrumentation systems used onboard complex, highly integrated flight research vehicles. Work with fault tolerant redundant microprocessor-based control systems, microprocessor-based measurement systems, transducers, actuators, techniques for system safety, and hazard analysis.

Victoria Regenie
(805) 258-3430

Flight Dynamics — Pilot/aircraft interaction with advanced control systems and displays, assessing and predicting aircraft controllability, developing flying qualities criteria, parameter estimation, and mathematical model structure determination.

Robert Clarke
(805) 258-3799

Flight Test Measurement and Instrumentation — Flow measurement, skin friction drag, fuel flow, integrated vehicle motion measurements, space positioning, airframe deflection, sensor and transducer miniaturization, and digital data processing.

Rodney Bogue
(805) 258-3193

Fluid Mechanics and Physics — Laminar and turbulent drag reduction configuration aerodynamics, experimental methods, wing/body aerodynamics, full-scale Reynolds number test technology, high angle of attack aerodynamics, applied mathematics, and atmospheric processes.

Robert Meyers
(805) 258-3707

Propulsion/Performance — Propulsion controls, integrated propulsion/airframe systems, and vehicle performance measurement.

Ronald Ray
(805) 258-3687**Structural Dynamics —** Aerostructural modeling, vibration and flutter analyses/predictions, aircraft flutter, flight envelope expansion, ground vibration and inertia testing, aeroservo/elasticity, active control of structural resonances, and advanced flight test technique development.

Mike Kehoe
(805) 258-3708

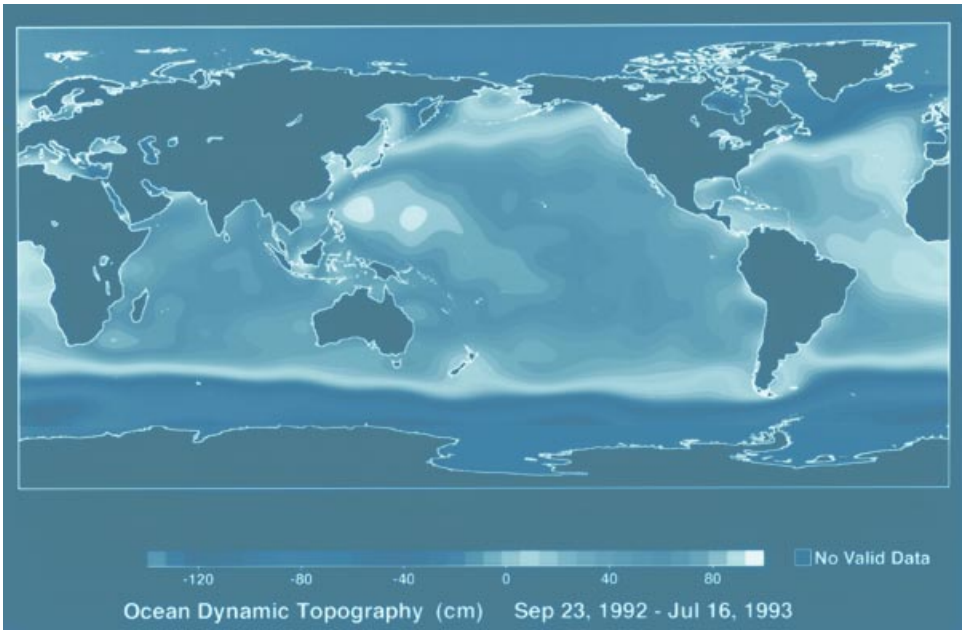
Hugh L. Dryden Flight Research Center

Aircraft Automation — Knowledge-based systems development, verification and validation of knowledge-based systems, neural networks, heuristic controllers, knowledge-based acquisition/implementation, maneuver controllers, performance optimization, guidance, pilot-vehicle interface, and robotic aircraft.

Lee Duke
(805) 258-3802

Integrated Test Systems and Aircraft Simulation — Development of Integrated System Test equipment, including aircraft/simulation interface equipment, automated test equipment, and applied artificial intelligence techniques for diagnosis and control. Flight simulation development for advanced aircraft systems in aerodynamic, propulsion, and flight control modeling.

Vince Chacon
(805) 258-3791



This map of ocean topography was produced using 300 days worth of data from the TOPEX/Poseidon radar altmeter.

Mission

Goddard Space Flight Center is NASA's lead center for the *Earth Observing System*, the central component of *Mission to Planet Earth*. This mission exemplifies Goddard's commitment to expanding knowledge of the Earth and its environment, the solar system, and the universe through observations from space. Goddard's six major laboratories include a broad range of Earth science activities (atmospheres, hydrology, biology and geophysics) related to understanding the Earth as a total ecosystem, as well as a full spectrum of space sciences (astronomy, astrophysics, planetary studies, and space physics) keyed primarily to observations from Earth-orbiting platforms. Strong engineering, flight dynamics, mission operations, communications, data, and computing facilities support these science objectives, allowing Goddard to carry out all aspects of a space-borne science mission from initial concept to final data archiving.

Located on an 1,100-acre campus in suburban Maryland just outside of Washington, DC, Goddard is home to over 4,000 civil servants and 8,000 on-site contractors. Scientific collaborations and industrial partnerships make Goddard the hub of a national and international arena spanning all aspects of science from space.

Goddard Space Flight Center

Greenbelt, MD

The mission of Goddard Space Flight Center is to expand knowledge of the Earth and its environment, the solar system, and the universe through observations from space. To assure that our nation maintains leadership in this endeavor, we are committed to excellence in scientific investigation, in the development and operation of space systems, and in the advancement of essential technologies.

Graduate Student Researchers Program opportunities are available in the Space Sciences Directorate, the Earth Sciences Directorate, the Engineering Directorate, and the Mission Operations and Data Systems Directorate. Research opportunities at Goddard's two remote facilities—the Goddard Institute for Space Studies in New York City and the Wallops Flight Facility on Wallops Island, VA—are included in these listings. Qualified applicants are strongly encouraged to explore areas of interests with the contacts listed prior to submitting a proposal.

All proposals should come to the program office in Greenbelt, MD.

Program Administrator

Dr. Gerald Soffen
Director of University Programs
NASA
Goddard Space Flight Center
Code 160
Greenbelt, MD 20771
(301) 286-9690
Internet address:
http://university.gsfc.nasa.gov/GSRP/GSRP.html

SPACE SCIENCES DIRECTORATE

The Space Sciences Directorate plays a leading role in conceiving and developing instruments and missions for the scientific exploration of space through its three research organizations:

Laboratory for Astronomy and Solar Physics

Laboratory for High Energy Astrophysics

Laboratory for Extraterrestrial Physics

The Orbiting Satellites project in the Directorate manages operating scientific spacecraft which were developed by Goddard. The Directorate's Space Science Data Operations Office designs, develops, and operates data management and archiving systems and provides public access to archived space science data.

Laboratory for Astronomy and Solar Physics — The Laboratory for Astronomy and Solar Physics (LASP) conducts a broad program of research in experimental and theoretical astronomy, solar physics, and cosmology. Astrophysical phenomena in the sun, stars, and galaxies, as well as the medium between them, are studied with emphasis on their structure, origin, and evolution.

Various groups are actively investigating galactic novae, AGN, starbursts and galactic evolution.

Two instruments for the Hubble Space Telescope (HST) have been provided by LASP: the Goddard High Resolution Spectrograph (GHRS), and its replacement, the Space Telescope Imaging Spectrograph (STIS). Data are in hand from the GHRS, and the STIS science team is making use of Guaranteed Telescope Observations (GTO) time to explore fundamental problems in high spatial and spectral resolution spectroscopy.

The Solar and Heliospheric Observatory (SOHO) is currently being operated by the laboratory, and there is much experimental and theoretical work on the structure and dynamics of the sun being done. A new version of the Solar Extreme Ultraviolet Rocket Telescope and Spectrograph (SERTS) is now in fabrication, featuring an all new telescope and detector, designed and developed in the LASP.

Within the lab is a strong instrument development program based on both rocket and balloon flights devoted to studying the solar corona, a variety of UV sources, and the cosmic IR and microwave backgrounds. In addition, IR imaging and spectroscopic instrumentation is being developed for ground-based observatories, the Stratospheric Observatory for Infrared Astronomy (SOFIA), and the Space Infrared Telescope Facility (SIRTF).

Goddard Space Flight Center

The Center is developing the Microwave Anisotropy Probe (MAP) for launch in 2001 and is actively pursuing the Next Generation Space Telescope (NGST) concept in collaboration with astronomers and engineers across the community. NGST, a large, infrared telescope, passively cooled to low temperatures, is being studied for launch late in the next decade. There will be many opportunities for technical studies of new instrumentation, new telescope designs, and next generation spacecraft operations.

There are several archival research programs in progress based on data from the Infrared Astronomy Satellite (IRAS), Infrared Space Observatory (ISO), Cosmic Background Explorer (COBE), Solar Maximum Mission (SMM), International Ultraviolet Explorer (IUE), and GHRS.

Charles Bennett
(301) 286-3902
Infrared Astronomy

Susan Neff
(301) 286-5137
UV-Optical Astronomy

Richard Fisher
(301) 286-5682
Solar Physics

Andrew Michalitsianos
(301) 286-8701
Laboratory Chief

Laboratory for High Energy Astrophysics — High Energy Astrophysics is the study, by way of X-rays, gamma rays, and energetic particles, of cosmic systems and sites and the physical processes operating therein. Studies of the mechanisms that release energy and accelerate particles, and of the thermal and non-thermal mechanisms that convert the kinetic energy of these particles into observable radiation, are the essential ingredients of high energy astrophysics. High energy observations and theory address some of the most fundamental problems in astrophysics: the accretion disks around, and magnetospheres of, massive compact objects such as neutron stars and black holes; abundance distributions of hot astrophysical plasmas such as stellar atmospheres, supernova remnants, galactic cosmic rays and intercluster gas; the origin of gamma-ray bursts; the natural acceleration of particles in space; the central engines of Active Galactic Nuclei; and the character and location of "dark matter" and the nature of large-scale extragalactic structures. A broad program of experimental and theoretical research is conducted in all phases of astrophysics associated with high energy particles and the quanta produced in the interactions with their environments. The observables are features such as compositions, time variability, spatial structures, and spectral features of the X-ray and gamma-ray emissions and particle populations. Experiments are designed, built, tested, and flown on balloons, rockets, Earth satellites and deep space probes. The resulting data are analyzed and interpreted by Laboratory scientists and their associates in the larger high-energy astrophysics community. These studies of the physics of solar, stellar, galactic, and metagalactic high-energy processes lead to development of theoretical models of the origins and histories of these particles and quanta, and provide understanding of the objects and environments in which they arise.

N. White
(301) 286-8443
Archival X-ray and gamma ray data analysis

E.A. Boldt
(301) 286-5853
Cosmological X-ray studies

J. Swank
(301) 286-9167
Stellar X-ray sources

R. Mushotzky
(301) 286-7579
Extragalactic X-ray sources

D. Thompson
(301) 286-8168
High Energy (>20MeV) gamma rays

N. Gehrels
(301) 286-6546
Low Energy (<20 MeV) gamma rays

T. L. Cline
(301) 286-8375
Gamma ray bursts

J. F. Ormes
(301) 286-8801
Cosmic Rays

R. Ramaty
(301) 286-8715
Theoretical studies

Goddard Space Flight Center

Laboratory for Extraterrestrial Physics — The Laboratory for Extraterrestrial Physics (LEP) performs experimental and theoretical research on the physical properties of and dynamical processes occurring in the interplanetary and interstellar media, magnetospheres and atmospheres of the planets, including Earth.

A major effort in the LEP is the analysis of data from spacecraft experiments flown on Voyagers 1 and 2, Ulysses, IMP-8, Geotail, Wind, Polar, Mars Global Surveyor, and suborbital rocket payloads. The research focuses on plasmas, magnetic fields, electric fields, and radio waves located in planetary magnetospheres and the interplanetary medium. Preparations are underway for delivery of the Composite Infrared Spectrometer and Plasma Spectrometer investigations on the Cassini mission to Saturn.

A program in infrared astronomy includes the study of spectra of the outer planets to deduce atmospheric properties. Studies of planetary atmospheres and the solar spectrum in the infrared are also conducted. An extensive program of research, including spectroscopy and physical chemistry related to astronomical objects, studies of molecules and chemical reactions of astrophysical and aeronomic importance are also conducted in special laboratory facilities. Research related to the chemistry and physics of planetary stratospheres and tropospheres, and solar system matter including meteorites, asteroids, comet, and planets also forms an important component of the LEP research.

A strong theoretical program exists which includes the study of solar wind turbulence, the modeling of the magnetosphere, the non-linear dynamics of the magnetosphere and the development of the next generation of adaptive grid MHD simulation codes.

Joseph A. Nuth
(301) 286-9467
Astrochemistry

L. Drake Deming
(301) 286-6519
Planetary Atmospheres, Infrared Spectroscopy & Molecular Structure

Thomas E. Moore
(301) 286-5482
Interplanetary Physics and Space Plasmas

Steven A. Curtis
(301) 286-9188
Planetary Magnetospheres

James A. Slavin
(301) 286-5839
Electrodynamics

Space Science Data Operations Office — This organization offers exceptional opportunities for computer scientists seeking to apply advanced data systems concepts to NASA's challenging space data problems. Areas of interest include massive on-line data management, web-based user interfaces, heterogeneous multi-source databases, and data visualization. Research is conducted on advanced data systems for scientific data management using expert systems, database machines, mass storage systems and computer visualization, and on developing interactive scientific data systems integrating data archiving, catalog, retrieval, data and image manipulation, and transmission techniques into distributed systems.

James Green
(301) 286-7354
Advanced Data Systems

Joseph King
(301) 286-7355
Mass Data Storage and Data Media

Greg Goucher
(301) 286-2341
Computer Visualization

Barry Jacobs
(301) 286-5661
Data Base Management

Space Physics Data Facility — This organization is engaged in a range of science research and information technology development efforts with mission such as Wind, Polar, and Geotail. Science areas of current interest include coordinated studies of magnetospheric structure and dynamics, trapped radiation modeling, low- energy cosmic ray studies and imaging of the Earth's magnetosphere with radio waves. The organization is active in data standards and the definition, implementation and operation of data systems supporting data acquisition and analysis from current and future space physics missions.

Robert McGuire
(301) 286-7794
Cosmic Rays

Goddard Space Flight Center

Mona Kessel
(301) 286-6595
Magnetospheric Dynamics

Shing Fung
(301) 286-6301
Trapped Radiation

Astrophysics Data Facility — This organization designs, develops and operates data systems that support the processing, management, archiving and distribution of NASA mission data. The staff manages data for specific missions in collaboration with the GSFC Space Science Laboratories and supports the astrophysics community's access to multi-mission and multi-wavelength data archive stored at GSFC. Opportunities exist to study a variety of astrophysical and applied information systems problems, using archived space- or ground-based data. Current areas of staff interest are the interstellar medium, clusters of galaxies, star formation and advanced database technology.

Cynthia Cheung
(301) 286-2780
Information Systems

Dave Leisawitz
(301) 286-0807
Astrophysics

HPCC/Earth and Space Sciences (ESS) Project — Goddard is interested in research which will improve the usability and performance of distributed memory supercomputers. Areas of particular interest include parallel computational techniques, management of massive amounts of data, architecture independent programming, virtual environments. This work is in support of ESS Grand Challenge science applications, which include multi-disciplinary modeling of Earth and space phenomena, and analysis of data from remote sensing instruments.

Jim R. Fischer
Goddard Space Flight Center
(301) 286-3465
fischer@jacks.gsfc.nasa.gov
See http://sdcd.gsfc.nasa.gov/ESS/

EARTH SCIENCES DIRECTORATE

The mission of the Earth Sciences Directorate is to provide leadership in achieving improved observations and understanding of global Earth systems processes and trends through the development and utilization of space technologies. The Earth systems being studied range from the deep interior (the core and the source of the magnetic field, the mantle, and its properties), through the surface (e.g., plate motion, soil formation, biospheric and hydrospheric processes, and ice studies), to the atmosphere (gaseous chemistry, trends, climate models), and beyond (the ionosphere, solar studies, and planetology). The Directorate keeps an aggressive basic and applied research program operating at a level which ensures strong vision and leadership while fulfilling its responsibilities encompassed by NASA and U.S. programs in Earth sciences.

Richard Hartle
(301) 286-8234

Global Change Data Analysis Center — The Global Change Data Center (GCDC) provides Earth science data operations and archive management to key Earth science flight missions. The Center ensures that data within the archive are readily accessible through the Goddard Distributed Active Archive Center (GSFC/DAAC) and operates key advanced data systems to support NASA flight missions. The GCDC interacts closely with the scientific community being served.

The Goddard DAAC Facility is responsible for the acquisition, archiving, and dissemination of scientific data from specific Earth science missions. It develops, implements, and operates the GSFC/DAAC data system; interfaces the GSFC/DAAC with the other NASA DAAC systems in order to provide timely access to archived data and information; provides special services for the Earth science communities; performs scientific analysis; and generates multi-disciplinary data bases. It also oversees management of the archival systems and facilities of the GCDC; maintains the archive and preserves valuable information content against physical deterioration of the storage media; and produces a regular publication promoting and informing the science user community of its archive contents and services.

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The Earth Science Data Operations Facility works closely with flight project personnel in data system planning and utilization, and develops and implements the capability to support Earth sciences mission needs. The Facility is responsible for supporting instrument algorithm development and operational project data set production systems; developing such systems for specific NASA flight projects such as the Earth Probes; and developing nationally accessible advanced data projects for the area of Earth science. It conducts research in advanced computer science methodologies for application to science data operations, and oversees management of the computer systems needed to process project data systems.

Stephen Wharton
(301) 286-9041
Global Change Data Center

Paul Chan
(301) 286-0828
Goddard DAAC Facility

Richard Kiang
(301) 286-2507
Earth Science Data
Operations Facility

Laboratory for Atmospheres — This laboratory performs a comprehensive theoretical and experimental research program dedicated to advancing our knowledge and understanding of the atmospheres of the Earth and other planets. The research program is aimed at advancing our ability to predict the weather and climate of the Earth's atmosphere; advancing our understanding of the structure, dynamics, and radiative and chemical properties of the troposphere, stratosphere, mesosphere, and thermosphere; determining the role of natural and anthropogenic processes on the ozone balance and climate change; and advancing our understanding of the physical properties of the atmospheres and ionospheres of the Earth and other planets.

Franco Einaudi
(301) 286-5002

Tropical Rainfall Measuring Mission (TRMM) Office — The TRMM Office provides the infrastructure for planning and implementing a Global Validation Program (GVP) to support the TRMM and to support the TRMM Science Team. The Office also conducts relevant scientific studies including rain measurement technology research, precipitation processes studies, radar algorithm development, and the development of methodologies for validating satellite measurements of rainfall.

Otto Thiele
(301) 286-9006

Data Assimilation Office — Data assimilation combines all available meteorologically relevant observations with a prognostic model to produce accurate time series estimates of the complete global atmosphere. This Office advances the state-of-the-art of data assimilation and the use of data in a wide variety of Earth system problems, develops global data sets that are physically and dynamically consistent, provides operational support for NASA field missions and Space Shuttle science, and provides model-assimilated data sets for the MTPE enterprise.

Richard Rood
(301) 286-8203

Mesoscale Atmospheric Processes Branch — This branch performs research on a broad range of meteorological problems ranging from convective cloud scale through synoptic scale to the global scale. The research emphasis is on the initiation, evolution, and impact on atmospheric precipitating systems and on the remote measurement of precipitation. Scientists in the branch employ theoretical and numerical modeling methods, observational analyses, and participate in sensor development for the measurement of precipitation. Specific topics include tropical and mid-latitude convective precipitation systems, fronts and gravity waves, tropical and extratropical cyclones, air-surface interactions, and global precipitation analysis. The branch also conceives and develops advanced remote sensing instrumentation to measure meteorological parameters with emphasis on lidar systems.

Robert Adler
(301) 286-9086

Climate and Radiation Branch— This branch conducts basic and applied research with the goal of improving the fundamental understanding of regional and global climate on a wide range of spatial and temporal scales. Emphasis is placed on the physical processes involving atmospheric radiation

and dynamics, in particular, processes leading to the formation of clouds and precipitation and their effects on the water and energy cycles of the Earth. Currently, the major research thrusts of the Branch are: climate diagnostics, remote sensing applications, hydrologic processes and radiation, aerosol/climate interactions, and modeling seasonal-to-interannual variability of climate.

William Lau
(301) 286-7208

Atmospheric Experiment Branch— This Branch conducts experimental research in terrestrial, cometary and planetary atmospheres concerning chemical composition, atmospheric structure and dynamics. Scientists and engineers in the Branch participate in scientific investigations from experiment conception through flight hardware development, space flight and data analysis and interpretation. Neutral, ion, and gas chromatograph mass spectrometers are developed to measure atmospheric gases from entry probes and orbiting satellites.

Hasso Niemann
(301) 286-8706

Atmospheric Chemistry and Dynamics Branch— This Branch conducts research aimed at understanding the radiation-chemistry-dynamics interaction in the troposphere-stratosphere-mesosphere system.. This Branch develops remote-sensing techniques to measure ozone and other atmospheric trace constituents important for atmospheric chemistry and climate studies, develops models for use in the analysis of observations, incorporates results of analysis to improve the predictive capabilities of models, and provides predictions of the impact of trace gas emissions on the ozone layer.

P. K. Bhartia
(301) 286-4094

Laboratory for Terrestrial Physics — The Laboratory for Terrestrial Physics (LTP) advances the scientific knowledge of the Earth and planetary solid-body physics. In the scientific branches, research is pursued on the distribution of mass within the Earth-ocean-atmosphere system, the origin of the Earth's magnetic field, the nature of the movement of the tectonic plates which form the Earth's crust, the effect of variation in the momentum of the atmosphere and changes in the hydrosphere on the Earth's rotation rate, the role of vegetation in the carbon cycle, the most efficient dataset required to detect and interpret change at the ecosystem level, and the nature of the interior structure of the Moon, Mars and Venus. The Laboratory has a significant capability to design, develop and test laser and electro-optic remote sensing instruments. The LTP has designed and managed several spacecraft instruments.

David Smith
(301) 286-8671
See http://ltpwww.gsfc.nasa.gov

Geodynamics — Research topics include the structure and composition of the Earth's interior through geodetic studies of the gravity and magnetic fields, the study of the lithosphere through magnetic anomalies, the rotational parameters of the Earth and planets, the measurement of topography with altimeters and the study of planetary landforms.

Herbert Frey
(301) 286-5450

Terrestrial Information Systems Advances research programs and institutional administrative activities through research in and applications of information technology. Activities include development of data systems to process and distribute information from Earth observing satellites, aircraft sensors, ground-based networks and field experiments, develop software for visualization, analysis, and presentation of scientific data.

Edward Masuoka
(301) 286-7608

Biospheric Studies — These include research on terrestrial ecosystem-atmosphere interactions, and ecological patterns and processes occurring at local, regional and continental spatial scales, as well as basic remote sensing research. A wide variety of remote sensing models and passive and active instruments are used to develop a fundamental understanding of the interaction of electromagnetic radiation with terrestrial surfaces. Laboratory, field, aircraft, and satellite investigations are used to characterize the spectral distribution, bi-directional reflectance, and polarization response of terrain features at visible, infrared and microwave frequencies. Techniques are developed to create, process, and analyze multi-year global datasets. Time series of

Goddard Space Flight Center

satellite data are used to study the seasonal dynamics of global vegetation, interannual variations in production of semi-arid grasslands, tropical forest alteration, and to provide improved surface characterization for input into global models.

Darrel Williams
(301) 286-8860

Laser Instruments — Designs and develops advanced electro-optic and laser sensors for ground-based, airborne and spaceborne Earth and planetary science investigations. Work includes laser and detector research, sensor development research and conceptual design, performance calculations, sensor engineering and fabrication, as well as calibration and integration. Sensors are used for measurements of Earth and planetary surfaces and of the Earth's atmosphere and oceans. The branch also develops advanced laser sensors, including laser altimeters and lidar systems, for airborne and spaceborne use.

James Abshire
(301) 286-2611

Space Geodesy — Research uses precise geodetic methods, including laser ranging and very long baseline interferometry, altimetry, data from highly accurate tracking systems such as GPS and doppler, gradiometry and satellite-to-satellite tracking to measure and study the motion of the Earth on its axis, the kinematics of plate motion, the deformation of the crust, the Earth and ocean tides, variations in sea level, and models of the gravity fields of the Earth and planets.

John Bosworth
(301) 286-7052

Laboratory for Hydrospheric Process — The Laboratory performs theoretical and experimental research on various components of hydrology and its role in the complete Earth science system. The program is aimed at observing, understanding, and modeling the global oceans and ice, surface water, and mesoscale atmospheric processes. The Laboratory conducts research on Earth observational systems and techniques associated with remote and in-situ sensing.

Antonio Busalacchi
(301) 286-6171

Oceans and Ice Branch — This Branch conducts oceans and ice research to enhance understanding of these systems and their relationships with other elements of the Earth's climate. Research focuses on problems in biological, physical, and polar oceanography; glaciology; and marginal ice zones, air-sea interactions, and coupled climate modeling. Pursues interdisciplinary studies on problems such as those involving productivity and carbon fluxes, upper ocean and thermohaline circulation of the oceans; ice/ocean coupling; and ice sheet dynamics are conducted.

Chester Koblinsky
(301) 286-4718

Observational Science Branch (Wallops Island, VA) — This Branch conducts theoretical and experimental research on observational systems and techniques for oceanic remote sensing. The Branch develops and operates research facilities (Air-Sea Interaction Facility, Rain-Sea Interaction Facility), aircraft remote sensors, and ground-based and balloon-borne ozone and meteorological sensors to obtain relevant Earth Science data and investigates associated sensor improvements and further technology developments. The Branch also investigates associated sensor improvements and further technology developments.

Laurence C. Rossi
(757) 824-1590

Hydrological Sciences Branch — The Hydrological Sciences Branch conducts research activities which contribute to an improved understanding of the exchange of water between the Earth's surface and its atmosphere. These research activities emphasize the use of remote sensing over a wide range of electromagnetic frequencies as a means of studying various hydrological processes and states, such as precipitation, evapotranspiration, soil moisture, snow and ice cover, and fluxes of moisture and energy. In addition, advanced numerical and analytical models are developed.

E. Engman
(301) 286-5480

Microwave Sensors Branch — This Branch performs research and development on advanced microwave sensing systems and data collection systems directed at providing remote and *in-situ* data for research in the areas of the oceans, ecology, weather,

climate, and hydrology. Performs basic theoretical , laboratory and field studies that elucidate the interaction of electromagnetic radiation with the environment to improve our understanding of remote sensing systems. Branch members contribute to the development of microwave science and engineering for the Tropical Rainfall Measurement Mission (TRMM), the Earth Observing System (EOS), and various airborne campaigns.

Les Thompson
(301) 286-9831

SeaWiFS Project — The Sea-viewing Wide-Field-of-view Sensor (SeaWiFS), to be launched on Orbital Sciences Corporation's SeaStar satellite in mid 1997, will provide global observations of ocean color for NASA. These data will be used to assess phytoplankton abundance, ocean productivity, and the ocean's role in the global carbon cycle. In addition, the observations will help visualize ocean dynamics and the relationships between ocean physics and large-scale patterns of productivity.

Charles McClain
(301) 286-5377

SIMBIOS Project — The Sensor Intercomparison and Merger for Biological and Interdisciplinary Oceanic Studies (SIMBIOS) Project will develop a methodology and capability to combine data products from various ocean color satellite instruments, e.g. SeaWiFS, OCTS, POLDER, and MODIS, in a manner that ensures the best possible global coverage. The developed merged data set will improve the ability to capture short term changes in the ocean more effectively than any individual ocean color mission. The data will then be used to assess phytoplankton abundance and model ocean primary productivity and associated atmospheric-ocean carbon transfer.

James L. Mueller
(301) 286-5723

Earth and Space Data Computing Division — The Earth and Space Data Computing Division (ESDCD) enables NASA-supported scientists to increase their understanding of Earth and its environment, the Solar System, and the Universe through the computational use of space-borne observations and computer modeling. To help assure the research success of NASA- and Goddard Space Flight Center (GSFC)-related projects and programs, we are committed to providing the science community with access to state-of-the-art high performance computing, leading-edge mass storage technologies, advanced information systems, and the computational science expertise of a staff dedicated to supporting that community.

The ESDCD manages and operates the NASA Center for Computational Sciences (NCCS), a primary supercomputing and data storage center for support of NASA missions and programs, and, on a national basis, for approved programs of the external NASA and university communities. The ESDCD utilizes state-of-the-art computational equipment and data systems to provide end-to-end support of computational research conducted by the Earth and Space Sciences Directorates at GSFC and to a somewhat lesser extent external NASA approved research investigators. Specifically, the ESDCD meets its science-driven requirements by providing specialized computational processing and archival services for approved projects and individual scientists as well. In addition, the ESDCD provides support in the areas of sensor algorithms for direct ground communications readout of satellite transmissions, information processing, discipline data base management systems, high performance computing and parallel processing, high speed local and wide area network support, and advanced science data visualizations systems.

The NCCS engages in the application of advanced computer system architectures, such as a suite of CRAY J932 computers, and scalable parallel machines such as the SGI/CRAY T3E, to support complex computational physics modeling efforts. These modeling efforts involve, for example, studies of coupled multi-dimensional ocean and atmospheric systems, multi-dimensional magnetospheric-ionospheric systems, and astrophysical processes. Specific research opportunities exist for development of new numerical algorithms in computational physics that utilize advanced computer architectures, development of advanced scientific visualization, algorithms for visualization of space and Earth science pro-

cesses, and the development of advanced techniques for managing decaterabyte mass data storage and delivery systems.

Jan M. Hollis
(301) 286-7591

GODDARD INSTITUTE FOR SPACE STUDIES (NEW YORK, NY)

The Goddard Institute for Space Studies conducts comprehensive theoretical and experimental research programs in four major areas.

Planetary Atmospheres — Concerned with investigations of Jupiter, Saturn, Venus, and the Earth. The observational phase of the program includes imaging and polarization measurements from the Pioneer Venus Orbiter and radiation-budget, temperature-sounding, photometric, and polarization measurements from the Galileo Jupiter Orbiter. The theoretical phase of the program includes interpretation of radiation measurements of planets to deduce bulk atmospheric composition and the nature and distribution of clouds and aerosols, and analytical and numerical models of planetary circulations. Emphasis in the theoretical program is on analysis of physical processes in terms of general principles and models applicable to all planets.

Michael Allison
(212) 678-5554

Anthony Del Genio
(212) 678-5588
Atmospheric Dynamics

Larry Travis
(212) 678-5599

Barbara Carlson
(212) 678-5538
Radiative Transfer

Causes of Long-Term Climate Change — Basic research on the nature of climate change and climatic processes, including the development of numerical climate models. Primary emphasis is on decadal or end-of-century global-scale simulations, including studies of humanity's potential impact on the climate. Climate sensitivity and mechanisms of climatic change are investigated in global paleoclimatic research, specifically from the comparison of pollen and glacial data with paleoclimatic model simulations. In addition to their use for climate simulations, the global models are used to simulate the transport of atmospheric constituents and thus study their global geochemical cycles. The program also includes development of techniques to infer global cloud, aerosol and surface properties from satellite-radiance measurements as part of the International Satellite Cloud Climatology Project and the Earth Observing System and analysis of the role of clouds in climate.

Anthony Del Genio
(212) 678-5588
Convection and Clouds

James Hansen
(212) 678-5619
Greenhouse Effect

Dorothy Peteet
(212) 678-5587
Paleoclimate, Pollen Studies

David Rind
(212) 578-5593
Climate Dynamics, Stratosphere

William Rossow
(212) 678-5567
Global Cloud Properties

Andrew Lacis
(212) 678-5595
Radiative Processes

Biogeochemical Cycles — Research on global biogeochemical cycles involving the study of chemically and radiatively important trace gases. The aim is to improve our understanding of the cycles of CO_2, CH_4, N_2O, CFCs, O_3, NOX, OH, and other trace compounds which are expected to affect climate and air quality in the near future. The research involves three-dimensional chemical tracer models, which are essential for determining the sources and sinks of these gases and for predicting future atmospheric composition. Central to the program is the investigation of the role of the biosphere, terrestrial and oceanic, in the global carbon cycle using a combination of satellite measurements and modeling.

Inez Fung
(212) 678-5590
Carbon Cycle, Ocean Modeling

Interdisciplinary Research — Interdisciplinary research ranges from theoretical studies of the origin of the solar system to relationships between the Sun, terrestrial climate, geological

processes, and biology. One phase of the program involves the structure and evolution of accretion disks, especially the primitive solar nebula, using models of large-scale turbulence. Another area concerns the evolution and pulsation of bright stars, which may be analogs of the Sun. A biological question of special interest concerns how terrestrial vegetation will change during the next 50 years, when climate and atmospheric CO_2 are expected to be changing.

Vittorio Canuto
(212) 678-5571
Turbulence

Richard Stothers
(212) 678-5605
Stars, Climate Studies

Dorothy Peteet
(212) 678-5587
Biology

Cynthia Rosenzweig
(212) 678-5591
Agronomy, Climate Impacts

ENGINEERING DIRECTORATE

The Engineering Directorate supports NASA Space and Earth Sciences and application programs through technical research and development. The Directorates enabling technology program increases knowledge and capabilities in areas necessary for the success of assigned NASA missions. The design, development and test of components, subsystems, instruments and spacecraft for multiple programs and projects is an important part of the mission of the Engineering Directorate. The Engineering Directorate oversees the in-house development of flight hardware and software including instruments, Attached Shuttle Payloads, and Small Explorer Spacecraft, and provides system and discipline engineering support for space and Earth Science missions such as the Hubble Space Telescope and Earth Observing System.

Michael Fitzmaurice
(301) 286-6185

Thermal Development Laboratory — This laboratory is responsible for the development of new thermal control technology for future NASA spacecraft. Current work efforts focus on such technologies as cryogenic heat pipes, two-phase capillary pumped loops, and heat pumps. The scope of the work encompasses concept development, breadboard to prototype testing, conduction of flight experiments, and analysis. The 7000 square foot laboratory/office area has numerous test loops. These range in size from small benchtop units to an 8 ft. by 30 ft. facility, which is the largest known modular two-phase test bed. A wide variety of instrumentation, data collection/processing, and other support equipment are available to support these testing efforts.

Theodore Swanson
(301) 286-3478

Optics Laboratory/Electro-Optics Laboratory — The Optics Branch conducts research and development programs in the optical sciences and engineering to support flight experiment development in the areas of high energy astrophysics, solar and stellar astronomy, atmospheric sciences, and ocean and terrestrial sciences. Specific research and development objectives include optical property characterization of solids and thin films, diffraction grating technology, optical system design and analysis, and advanced optical fabrication and testing. Modern laboratory facilities are equipped for optical property studies in the far-infrared to extreme ultraviolet, generation of holographic diffraction gratings, and optical fabrication and testing. In addition, extensive computer facilities are available to support optical design and analysis studies.

The Electro-Optics Laboratory conducts applied research in electro-optics including high power semiconductor lasers, diode pumped solid state lasers, photo refractive filters, acousto-optic tunable filters, Fourier transform interferometers and photon counting detectors for remote sensing instruments. A major thrust is the investigation of the use of laser diodes as the transmitter source for active remote sensing instruments. Both the physics and engineering aspects of these systems are under investigation. Instrumentation is being developed and demonstrated for ground-based and flight observational research from ultraviolet to infrared wavelengths.

John Osantowski
(301) 286-3873

Goddard Space Flight Center

Ritva Keski-Kuha
(301) 286-6706
Michael Krainak
(301) 286-2646

David Glenar
(301) 286-3354

Electromechanical Systems Branch — Develops mechanical, optomechanical, and electromechanical systems required to support flight instrument and spacecraft projects. Conducts advanced and supporting research and development efforts to support new technology, such as magnetic bearings and cryogenic mechanisms, applicable to existing and future spaceflight requirements. Deployable appendages such as magnetometer booms and 100 meter long electric field antennas are developed. Flight structures ranging in size from small optical benches to instruments weighing several tons are provided. Electromechanical systems and their control electronics are developed, taking into account the effect of spacecraft structural disturbances (jitter) where applicable. Modern laboratory facilities are equipped for electromechanical fabrication and testing.

Mike Hagopian
(301) 286-7854

Willie Blanco
(301) 286-3637

Cryogenics Laboratory — This laboratory conducts research and development programs in low temperature physics in support of astrophysics goals. General research objectives are the development of low temperature microcalorimeters for the detection and imaging of charged particles and radiation, and high-precision and high-accuracy thermometry. Current research focuses on detectors and sensors using thin-film superconductors. This includes the development of detectors using tunnel junctions to obtain energy and/or spatial resolution, kinetic inductance calorimeters, and thermometry using superconductors. Modern laboratory facilities are equipped for detector characterization, including cryogenic workstations with automated data collection, SQUID systems, dilution and adiabatic demagnetization refrigerators, and facilities for evaporation and sputtering of thin films.

Stephen Castles
(301) 286-5405

Mechanical Engineering Branch — The Mechanical Engineering Branch performs structural and mechanical design for in-house STS and ELV launched spacecraft, instruments, and mechanical ground support equipment. These designs include spacecraft and instrument primary and secondary structures; deployable appendages such as solar arrays and antennas; flight mechanisms such as actuators, hinges and release mechanisms; and mechanical ground support equipment such as lift slings, dollies, containers, and g-negation hardware. The Branch also provides support for fabrication, assembly, integration, and testing of spacecraft and instrument structures including structural design research and design optimization of advanced composite materials. The Branch performs structural analyses in support of flight hardware design and testing and provides advanced development for maintaining state-of-the-art CAD/CAM technology.

James Ryan
(301) 286-6003

Gary Jones
(301) 286-5837
Mechanical Systems Division

MISSION OPERATIONS AND DATA SYSTEMS DIRECTORATE

The Mission Operations and Data Systems Directorate is responsible for the following: (1) planning, design, development, and operation of spaceflight tracking and communications networks and data systems support of near-earth spaceflight missions; (2) activities in mission planning, mission analysis, space and ground network operations, spacecraft and payload command and control, flight dynamics, information processing, and flight mission operations; (3) planning and applied research development of advanced data systems and telecommunications systems in support of spaceflight missions; and (4) ensuring that space and ground communications network, mission analysis and support computing capabilities, and end-to-end data systems meet mission support requirements and are maintained at the state of the art.

Donald Wilson
(301) 286-7550
New Technology and Data Standards Manager

Goddard Space Flight Center

Data Systems Technology Division
The Data Systems Technology Division develops and applies systems, hardware, and software technologies to support complex command and control, communications, and telemetry data processing requirements for future space missions. The Division also supports work in the area of advanced information management. The Division performs advanced technology development in such areas as: high performance VLSI systems for telemetry processing, high data rate/volume data storage architectures, distributed systems and networks, computer-aided software and systems engineering, human-machine interface and interaction technologies, artificial intelligence (especially in the areas of expert systems, agents, model-based reasoning, neural networks), planning and scheduling, monitoring and control, data and information visualization, virtual environments, and intelligent information management. The Division also engages in usability testing and cognitive studies associated with human/system interactions. Application projects include VLSI-based telemetry front-end processors, a computer-aided systems engineering support environment, and an agent technology test bed. Division laboratory facilities provide some of the most advanced systems design and development capabilities available, including a complete suite of VLSI design tools, libraries, and workstations; advanced commercial parallel disc farms; VME components for system integration; workstations including SUN, HP, and Silicon Graphics; advanced tools for system and software engineering, modeling and human/computer interface design; and expert system shells and development environments.

Nick Speciale
(301) 286-8704
VLSI systems

Sylvia Sheppard
(301) 286-6663
Human-Machine Interfaces
Computer Aided
Systems Engineering

Julia Breed
(301) 286-5049
Software Engineering

Walt Truszkowski
(301) 286-8821
Artificial Intelligence

Flight Mechanics Branch — The Flight Mechanics Branch (FMB) provides various support functions to the flight projects, tracking networks and scientists throughout a mission's lifetime. The FMB provides these functions from the early mission support of analyzing mission requirements and the development of ground determination systems that will be used for launch and normal operations, to the normal operations activities of producing mission planning products and verification of attitude and orbit performance.

The FMB analysis process is divided into three major areas of technical expertise. The attitude determination and control, the orbit determination, mission design and control, and the vehicle and network areas. The attitude determination and control area is responsible for the analysis, operational support and verification of the mission's attitude estimation and pointing, and the on-board sensors related to attitude determination. The orbit determination, mission design and control area is responsible for the analysis, operational support and verification of the mission's navigation systems and orbital trajectories. The vehicle and network area is responsible for planning, analysis and operational support for Space Shuttle acquisition data, expendable launch vehicle trajectory definition, and system engineering and tracking data evaluation for NASA and NASA affiliated networks. Representatives from these three areas work closely with the Project Office, scientists, tracking networks, and the spacecraft manufacturer to ensure that all requirements are met to provide for a nominal mission. All three areas support advanced research for the analysis and algorithm development of new and innovative operations support.

The attitude determination and control area draws upon experience from several technical disciplines. The areas of special interest include engineering, mathematics, estimation theory, control theory, physics, and classical mechanics. Currently research and analysis items active within the organization include:

- Studies related to analyzing attitude sensor performance and calibrations
- Advanced attitude determination algorithm development and analysis (such as using GPS)

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- Advanced estimation techniques for all attitude related topics (such as Kalman Filtering)
- Development of new techniques and algorithms for sensor/instrument calibration
- Studies related to the performance characterization and improvement of attitude control systems

The orbit determination, mission design and control area draws upon expertise from several technical disciplines. The areas of special interest include engineering, mathematics, physics, estimation theory, and orbital mechanics. Currently research and analysis items active within the organization include:

- Advanced orbit determination algorithm development and analysis (such as on-board or ground processing with TDRS, ground trackers and GPS)
- Development of new targeting techniques and algorithms for trajectory optimization and control (such as lunar swingbys and libration orbits, and automated maneuver control)
- Analysis for development of algorithms for generation of orbit related planning products (such as automated acquisition data)
- Advanced estimated techniques for orbit determination (such as Kalman Filtering)

The vehicle and network area draws upon expertise from several technical disciplines. The areas of special interest include engineering, mathematics, physics, estimation theory, orbital mechanics and electronics. Currently research and analysis items active within the organization include:

- Utilization and applications of advanced orbit determination systems
- Development of new techniques and algorithms for spacecraft, navigation and tracking system support
- Knowledge and application of tracking systems operations and their associated error sources, and data transmission to orbit determination and tracker pointing
- System engineering to ensure compatibility among spacecraft, tracking systems and flight dynamics

Thomas Stengle
(301) 286-5478

Suborbital Projects and Operations Directorate

Wallops Flight Facility
(Wallops Island, VA)

The Suborbital Projects and Operations Directorate's (SPOD) mission is to provide support to the scientific community through frequent rocket, balloon, and aircraft flight opportunities. The major activities conducted by the Directorate are:

Sounding Rocket Program —This program provides "cradle to grave" support to an investigator by designing and analyzing a mission to meet the science requirements; designing, fabricating, and testing the spacecraft; and integrating the spacecraft with a suborbital rocket system, providing project management and launch operations from numerous worldwide launch locations, and providing the reduced data to the scientist.

Balloon Program — This program provides the science community with access to the upper atmosphere for extended durations from numerous worldwide locations. The projects are conducted by a contractor at the National Scientific Balloon Facility in Palestine, Texas. The SPOD manages the overall program and performs research and development activities. The balloon program is beginning a major new research effort this year to develop balloon systems capable of staying aloft for approximately 100 days.

Orbital Projects — Wallops is in the process of assuming new responsibilities for management and implementation of small orbital spacecraft missions that are launched by expendable launch vehicles for aboard the Space Shuttle. The missions are expected to include University Explorers, Space Experiment Modules (SEM), Get-Away-Special (GAS), and Spartan Lite.

Aircraft Program — This program utilizes aircraft as a platform to carry scientific payloads to lower altitudes than the Sounding Rocket and Balloon programs. In addition to aircraft operations and maintenance, the SPOD provides project management and engineering necessary to conduct scientific measurements including the integration of experiments on aircraft and modifications of aircraft structures. The program also operates a launch

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range support aircraft and an administrative aircraft. Wallops is beginning new efforts to utilize remotely piloted aircraft to support projects previously requiring piloted aircraft.

Launch Range — In support of NASA's rocket-based science and technology launch requirements, the SPOD maintains and operates a launch range. NASA projects include launches of scientific sounding rocket payloads, orbital spacecraft, and new technology vehicles and payloads. This support includes project management, telemetry and radar tracking, communications, range safety, ordnance handling, data reduction, and other support services necessary to a range user. In support of these activities, the SPOD provides numerous facilities including a Range Control Center, assembly and storage facilities, blockhouses, and rocket launchers. The launch range also supports numerous other users including DoD and commercial customers. The SPOD also operates a complete mobile launch range capable of supporting rocket launches throughout the world.

Research Airport — The WFF airport serves the dual role of providing a home to the SPOD and visiting aircraft and also to support aeronautical research. The airport has numerous characteristics including textured surfaces, a water ingestion testing pit, calibration points, arresting gear, and the ability to utilize radar and telemetry ground systems for data acquisition.

Orbital Tracking — The SPOD provides ground station support for more than a dozen of NASA's low-earth orbiting satellites at WFF. Additionally, it provides mobile orbital tracking support at various locations throughout the world. Presently, there are substantial engineering efforts ongoing in this area which will lead to highly automated ground stations.

Educational Programs — Wallops provides educational opportunities to student organizations by providing flight opportunities on sounding rockets and balloons. The activities are similar to those of traditional science project support, however, a special emphasis is placed on the educational aspects of developing flight experiments and conducting launch operations. This activity will grow to include flight opportunities on the Space Shuttle through the Space Experiment Module missions.

B. Underwood
(757) 824-1613
Office of Policy and External Relations

The Galileo Probe separating from the Galileo Orbiter on July 13, 1995.

Mission

Conduct challenging robotic space missions for NASA

- Explore our solar system
- Expand our knowledge of the universe
- Further our understanding of Earth from the perspective of space
- Pave the way for human exploration

Apply our special capabilities to technical and scientific problems of national significance

As the nation's lead center for the robotic exploration of space, the Jet Propulsion Laboratory (JPL) is responsible for a broad spectrum of space science missions and instruments. In carrying out our work for the National Aeronautics and Space Administration (NASA), we have developed skills and capabilities unique to deep space exploration. Through our flight projects, we have traveled beyond Earth to study the solar system, visiting every planet except Pluto. The Laboratory plays a significant role in advancing the frontiers of space physics, astrophysics, and Earth observational science for the nation's benefit.

Jet Propulsion Laboratory

Pasadena, CA

The primary role of the Jet Propulsion Laboratory (JPL) within NASA is the exploration of the solar system, including planet Earth, by means of unmanned, autonomous spacecraft and instruments.

JPL scientists, technologists and engineers engaged in Earth atmosphere and geosciences, oceanography, planetary studies (including asteroid and comet), and solar, interplanetary, interstellar, and astrophysical disciplines. Opportunities for Graduate Student Researchers exist in all technical divisions of JPL. These technical divisions encompass almost all JPL engineering and science resources. Each technical division is concerned with the planning, design, development engineering, and implementation functions relevant to its discipline area. Fundamental to the structure of JPL is the cooperation among the functions of research, science, advanced technology, and engineering of these operating divisions.

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SYSTEMS DIVISION

The Systems Division performs systems engineering and design integration for all the major projects undertaken by JPL. It also conducts specialized analyses in many disciplines to support these projects.

Mission Design — Includes interplanetary spacecraft trajectory design, planning mission timelines to accommodate science requirements, launch vehicle trajectory analysis, studies of advanced interplanetary scientific missions, and software development to support mission design and analysis.

Spacecraft Systems Engineering — Supports JPL flight projects by providing design integration of the total spacecraft system, including its interfaces with the launch vehicle and with its scientific instrument payload. It also conducts studies and analyses of advanced future spacecraft designs and analyzes the performance of spacecraft in flight.

Navigation Systems — Develops the capability to determine very precisely the position and velocity of scientific spacecraft in interplanetary space through radiometric and optical techniques, designs propulsive maneuvers to place spacecraft on correct trajectories, develops complex software to solve the equations of motion, and conducts scientific studies of relativistic gravity, planetary orbital dynamics, gravitational radiation and planetary masses and gravity fields using spacecraft radio tracking data.

Mission Profile and Sequencing — Develops the detailed sequences to be executed by interplanetary spacecraft, plans the commands required to carry out the sequences, and develops the software that keeps track of the command sequences and ensures the commands will safely perform the desired functions. Provides support to science activity development and implementation. Conducts research related to planning and sequencing software technology.

Project Test and Operations — Performs planning, management and performance of test, integration and launch activities for major systems, including spacecraft, science instruments, ground data systems and ground support equipment. Conducts research and development for integration and test technologies and operates and manages JPL's major Spacecraft Assembly Facility.

Mission Information Systems Engineering — Supports JPL flight projects in the development of plans for the operation of interplanetary spacecraft in flight. This involves design of the end-to-end data system from the spacecraft instrument to scientist receiving the data.

Systems Analysis — Performs economics, operations research, costing, and mission analyses for a broad spectrum of unmanned and and manned space projects and military and civilian ground-based programs.

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Technology and Applications Systems Engineering — Performs system level design, integration, and development of information systems, including computer hardware and software and large distributed near real time ground data processing. Disciplines include traditional electrical, mechanical, aeronautical, and aerospace engineering, along with computer science, operations research, economics, and the physical sciences.

Kent Frewing
(8l8) 354-6780

EARTH AND SPACE SCIENCES DIVISION

The Division conducts a wide-ranging program of research in oceanography, the atmospheres and solid bodies of Earth and other planets, planetary satellites, asteroids, comets, interplanetary medium, and selected solar, stellar, and interstellar phenomena. Ground-based observations, aircraft, balloons, and Earth-orbiting and planetary spacecraft are utilized. Extensive laboratory and theoretical research efforts, data analysis, interpretation, and modeling support these observational programs.

Clifford Heindl
(818) 354-4603

Oceanography — Altimetry for determining currents and tides; air-sea interactions including, fluxes of mass, momentum, energy, and chemicals between ocean and atmosphere; determination of marine biomass and ocean productivity; sea ice dynamics and influence on climate variability; global surface temperature measurements; surface driving forces and wave propagation derived from radar observations.

Lee-Leung Fu
(818) 354-8167

Earth Atmosphere — Laboratory research, field measurements, and data analysis to understand the chemistry of stratospheric ozone; monitoring of long-term trends in important minor and trace constituents; extraction of meteorological parameters from satellite data, including temperature profiles, humidity, clouds, winds, and pressure.

James Margitan
(818) 354-2170

Planetary Atmospheres — Observations from ground-based telescopes and analysis of spacecraft data to determine composition, structure, and dynamics; long-term study of seasonal and inter-annual variability; global mapping; synthesis of information to determine physical processes and state of the atmospheres.

Jay Goguen
(818) 354-8748

Earth Geoscience — Characterization of exposed rocks, sediments, and soils on the Earth's surface to understand the evolution of the continents; examination of the state and dynamics of biological land cover for assessment of the role of biota in global processes; tectonic plate motion; volcanology; paleoclimatology.

Ronald Blom
(818) 354-4681

Planetology — Observations of the surface of the inner planets, the satellites and rings of the outer planets, asteroids and comets across the spectral range from ultraviolet through active and passive microwaves; studies of meteorites and cosmic dust; theory and modeling relevant to the origin and evolution of the solid bodies of the solar system; development of approaches to the detection and characterization of solar systems around other stars.

Bruce Banerdt
(818) 354-5413

Space Physics — Mapping of the magnetic fields of the Sun and planets and their time variations; structure and dynamics of the solar wind; interactions of solar fields and particles with the magnetic fields and outer atmospheres of Earth and planets.

Marcia Neugebauer
(818) 354-2005

Astrophysics — Sky survey of infrared sources; composition and chemistry of interstellar clouds; identification of gamma-ray sources within the galaxy and beyond; observations of supernova 1987A; studies of gravitational wave detection utilizing spacecraft.

Michael Janssen
(818) 354-7247

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TELECOMMUNICATIONS SCIENCE AND ENGINEERING DIVISION

Astrophysics — Observational and theoretical research into the nature of radio emissions from quasars, galaxies, and stars.

Robert Preston
(818) 354-6895

Planetary Atmospheres and Interplanetary Media — Experimental and theoretical research investigations based on the use of spacecraft radio signals to probe planetary atmospheres and the interplanetary/solar plasma.

Richard Woo
(818) 354-3945

Planetary Dynamics — Determination of orbital, rotational, or atmospheric motions of planets by tracking of spacecraft or balloons associated with the planets.

Robert Preston
(818) 354-6895

Asteroid Dynamics — Study orbital evolution of main belt and planet crossing asteroids, resonances, and asteroid families.

James Williams
(818) 354-0866

Geodynamics — Experimental and theoretical investigations of global and regional phenomena using the modern space geodetic techniques of lunar laser ranging, Very Long Baseline Interferometry (VLBI) and the Global Positioning System (GPS).

Jean Dickey
(8l8) 354-3235

Information Theory and Coding Theoretical research into information theory, channel and source coding with special emphasis on very noisy channels. Smaller interest in communication theory, detection and estimation of weak symbols, bandlimited channels, and fading channels.

Fabrizio Pollara
(818) 354-4287

Optical Communication — Theoretical and experimental research involving free space laser communications systems, components, and techniques, and including such items as lasers, detectors, modulators, signal design, large telescope design, spatial and temporal acquisition and tracking, detection strategies, and channel coding.

James Lesh
(818) 354-2766

Frequency Standards Research Experimental investigations in the area of quantum electronics and quantum optics, including ion and atom trapping and tooling, for the development of ultra-stable sources of microwave and optical reference frequencies.

Lute Maleki
(818) 354-3688

Planetary Radar Astronomy — Experimental and theoretical research in planetary surfaces, atmospheres, and rings (including geology, spin dynamics, and scattering properties of rings and cometary debris swarms) using the ground-based Goldstone radar system, the Very Large Array, and Arecibo Observatory to form images of terrestrial planets, asteroids, and comets.

Martin Slade
(818) 354-2765

Radar Remote Sensing of the Earth — Experimental and theoretical investigations in remote observation of the Earth's surface through radar scattering properties, for example, polarization and interferometry to determine the structure and motion of regions of interest.

Jakob Van Zyl
(818) 354-1365

Microwave Antenna Holography Experimental and theoretical research in microwave antenna holography and related topics. These include: phase retrieval, prescription retrieval, antenna design and optimization techniques, and advanced development of antenna measurement and instrumentation.

David Rochblatt
(818) 354-3516

Atmospheric Remote Sensing — Experimental and theoretical investigations of water vapor in the Earth's atmosphere. Emphasis on providing active calibration

of the delay imposed on radio and optical remote sensing techniques.

George M. Resch
(818) 354-2789

AVIONIC SYSTEMS AND TECHNOLOGY DIVISION

Advanced Spacecraft Control Systems — System architectures, sensors, actuators, and algorithms for autonomous rendezvous, docking, aerobraking, and landing. Development of concepts to enable high bandwidth control of flexible space structures and to provide active space control. Development of concepts to enable space interferometry missions.

Tooraj Kia
(818) 354-5165

Multi-mission Spacecraft Avionics Core — Develop and design an avionics core for instruments and interplanetary spacecraft. Establish requirements and minimum core architecture that is scalable. Architecture must allow reuse of software, documentation and development tools across multiple missions.

Tooraj Kia
(818) 354-5165

Spacecraft Autonomy — Architecture to facilitate robust and testable fully autonomous spacecraft. Autonomous position determination, autonomous guidance laws, autonomous attitude maneuvers, autonomous target acquisition and tracking, autonomous spacecraft resource management, autonomous fault detection, isolation, and recovery. Fully autonomous guidance, navigation, and control of interplanetary spacecraft propelled by ion propulsion systems.

Doug Bernard
(818) 354-2597

Autonomous Control Systems — Development of advanced control methods and concepts for autonomous spacecraft stabilization, pointing and tracking. Integration of miniature/feature trackers, gyros and advanced metrology systems. In-flight identification, estimation and control strategies for space interferometers. Development of a new generation of control design, modeling, and simulation tools.

David Bayard
(818) 354-8208

Precision Landing — Research in advanced autonomous control concepts, architectures, design methodologies and algorithms for high precision landing on large and small planetary bodies. Image-based pointing and control.

Fred Y. Hadaegh
(818) 354-8777

Formation Flying Control — Research in advanced control architectures, algorithms, simulations and testbeds for autonomous high precision control of formation flying of spacecraft. Design of optimal maneuvers for targeting and formation reconfigurations. Advanced algorithms and design concepts for autonomous multiple bodies rendezvous and docking with emphasis on image based pointing and tracking.

Fred Y. Hadaegh
(818) 354-8777

Formation Flying of Multiple Spacecraft — Research in optical and RF formation flying sensors, testbeds, along with integration and testing for multiple spacecraft formations (including rendezvous and docking) in Earth orbit and deep space.

Kenneth Lau
(818) 354-9749

GPS Based Attitude Determination — Performance improvement through active multipath suppression and passive multipath mitigation (e.g., configuration, RF absorbing materials).

Kenneth Lau
(818) 354-9749

Control of Inflatable Antennas — Research in modeling, pointing control, vibration control, and shape control of large, inflatable systems. Analysis and control of optical/RF performance and structural dynamics.

Sam Sirlin
(818) 354-8484

Interferometer Technologies — Development and design of high fidelity optical and structural component models for multi-disciplinary modeling (thermal, structures, controls and optics). Control systems with massively distributed sensors and actuators,

Jet Propulsion Laboratory

innovative high bandwidth controls, fault detection and recovery.

Sanjay Joshi
(818) 354-0451

Interferometric Metrology Systems — Development and testing of space-qualifiable systems and system components for interferometric metrology applications. Frequency stabilized laser sources, integrated optics components, fiberoptic components.

Serge Dubovitsky
(818) 354-9796

Precision Mechanisms and Motion Sensing — Innovative devices for rotating and displacing optical components to high precision and at high bandwidth (e.g., for active and adaptive optics and optical interferometry), and devices for sensing such motion.

Lynn Gresham
(818) 354-6974

Autonomous Vehicles — Real-time path planning in uncertain terrains; locomotion and mobility, computer vision for rover control, and combined mobility and manipulation.

Brian Wilcox
(818) 354-4625

Rover Technology — Rover navigation in uncertain terrains, rover localization, sample acquisition from small rovers, intelligent rover based science experiments.

Dr. Samad Hayati
(818) 354-8273

Robot Arm Control — Research in advanced manipulator control, adaptive arm control, control of redundant arms, cooperative dual-arm control, force and impedance control, motion planning and control of robotic vehicles, robot control architectures, task-level control, sensor-based motion planning and control, intelligent control of robots.

Homayoun Seraji
(818) 354-4839

Robotics Man-Machine Systems — Development of controls, sensing, manual and graphics-based user interfaces for telerobotic operations and telepresence. Applications to robotic space servicing and exploration and medical robotics.

Homayoun Seraji
(818) 354-4839

Optical/Digital Pattern Recognition — Research and technology development in algorithm, architecture, hardware implementation of pattern recognition systems using both optical and digital implementations. Processing methodologies of interest include: correlation, wavelet transforms, mathematical morphology and neural networks. Hardware implementations will be emphasized on Fourier optics and customized DSP.

Tien-Hsin Chao
(818) 354-8614

Machine Vision Systems — Development of algorithms for visual shape and motion estimation, object recognition, and pose estimation for applications in space flight and planetary exploration. Such applications include autonomous rendezvous and docking, autonomous landing, robotic maintenance of earth-orbiting spacecraft, and planetary rovers. Also interested in development of advanced imagers and high performance, low power, onboard computing hardware for these applications

Larry Matthies
(818) 354-3722

Vis/UV/X-ray Sensor Technology — Investigation of advanced materials and devices for the detection of electromagnetic radiation in the visible through low-energy x-ray wavelength regime. Development of high-performance backside- illuminated charge-coupled devices, rejection and anti reflection coatings, and space science instrument concepts. Research on wide bandgap semiconductor materials for solar-blind detectors.

Paula Grunthaner
(818) 354-0360

Infrared Detectors — Investigation of III-V based new device structures for infrared radiation detection. The research involves studying intersubband absorption, interband absorption and carrier transport properties in III-V superlattices and multi- quantum well structures.

Sarath Gunapala
(818) 354-1880

Jet Propulsion Laboratory

Advanced In-Situ Sensors and Devices — Design, research and development of advanced chemical microsensors, electrochemically based selective chemical sensors, and advanced miniature spectroscopic and x-ray diffraction instrumentation for planetary and other remote environments. Use of high temperature solid electrolyte electrochemical cells for thermal to electric power conversion (AMTEC), *in-situ* propellant production, and atmosphere processing.

Roger Williams
(818) 354-2727

MEMS Technology — Research and development in micromachining technology, modeling, reliability, and integration. The microfabrication facilities in MDL are used extensively to develop innovative fabrication approaches to demonstrate next-generation micromechanical devices for a variety of *in-situ* instruments.

William C. Tang
(818) 354-2052

Electric Power Research and Engineering — Development of lightweight, high-power fuel cells; high efficiency thermal-to-electric conversion; high-efficiency photovoltaic conversion; high energy batteries; and high-density power microelectronics.

Perry Bankston
(818) 354-6793

Flight Microelectronics Systems — Research and development of advanced microelectronics computing and avionics systems technologies, including: Semiconductor technologies for scaled voltage, power, and feature size; Ultra Low Power devices, architectures, and systems; Radiation Tolerant electronics, architectures and systems design; Advanced flight computer design, performance modeling, benchmarking and evaluation; Memory systems for both volatile and non-volatile storage (SRAM/DRAM/Flash, Holographic storage, etc.); Low Power I/O architectures; high-speed interconnect networks; commercial off the shelf architectures for low-cost system applications; Fault Tolerant systems, including hardware and software fault-tolerance using off-the-shelf components; Modeling and analysis of FT systems. Design Automation techniques for Design for Testability and Built In Self Test; Advanced Microelectronics Packaging, such as chip stacking in 3D, MCMs, and MCM stacking in 3D; Collaborative engineering, integration and testing.

Leon Alkalai
tel: (818) 354-5988
fax: (818) 393-5007

Advanced Multi-Mode Avionic Design — Development of advanced designs that incorporate analog/digital optoelectronics and/or RF on one substrate. Development of the design tools necessary for such devices. Development of specific avionic equipment utilizing such devices (I/O interfaces, switching circuitry, etc.).

John Klein
tel. (818) 354-2603
fax (818)393-4944

Data Storage Technology — Investigation of hybrid magnetic-semiconductor memory devices for the development of memory and data storage modules for space applications. Development of design, simulation, and experimental capabilities to validate technologies including Bloch Line and magnetoresistance-based devices for space data storage applications. Investigation of magneto-optical and optical data storage technologies, including holographic data storage, for space mass-storage applications.

Romney Katti
(818) 354-3054

Magnetic Device Technology — Investigation of magnetic devices such as microinductors, microtransformers, and magnetically actuated devices for space applications.

Romney Katti
(818) 354-3054

Concurrent Processing Using Analog/Digital Hardware — Research in architectures and algorithms related to neural networks, fuzzy logic, genetic algorithms, cellular automata, evolvable hardware, and other similar VLSI-based analog and digital parallel processing devices.

Taher Daud
(818) 354-5782

Advanced Computing Technologies — Research and technology development in architectures and hardware-implementable algorithms in the area of neural net-

works and fuzzy expert reasoning, quantum mechanics, and biological computing as related to spacecraft data analysis.

Benny Toomarian
(818) 354-7945

Neural Network Algorithms — Advanced neural algorithms for spacecraft control, autonomous rendezvous, docking, and landing. Development of feature extraction and tracking algorithms for small body spin vector and shape estimation. Application of neural networks to multi-sensor integration.

Benny Toomarian
(818) 354-7945

MECHANICAL SYSTEMS DIVISION

The Mechanical Systems Division carries out research in propulsion, cryogenics, structures, mechanical systems, materials, and thermal sciences. Research opportunities exist in materials with unique electro-mechanical and optical properties, active control of structural shape and vibration, inflatable structures, chemical sensors, cryogenic cooling systems including sorption coolers and integration of mechanical coolers with instruments, advanced superfluid helium cryostats, electric propulsion, autonomous mobility systems and remote sample acquisition.

Charles Lifer
(818) 354-6580

INFORMATION SYSTEMS DEVELOPMENT AND OPERATIONS DIVISION

The Information Systems Development and Operations Division performs research, development, planning, and operations related to ground-based information systems for spacecraft missions and other tasks in the national interest. Activities include: (1) mission operations engineering, technology, control, and data management, (2) information systems engineering, technology, and services, (3) ground data systems applications engineering and development, (4) space and institutional networks engineering, and (5) advanced information systems technology development and applications.

Research areas include: (1) advanced automation for spacecraft and ground system operations, (2) machine learning and applications, (3) simulation, modeling, and expert systems, (4) high-rate, high-capacity distributed information systems, (5) software productivity and reliability, (6) high-performance computing and supercomputing, and (7) low-cost mission operations.

Robert Tausworthe
(818) 306-6284

OBSERVATIONAL SYSTEM DIVISION

The Observational Systems Division is responsible for the conception, design, engineering, development, and implementation of a variety of scientific instrumentation for space flight applications. Key elements in the division are digital image processing research and development for space science, environmental and Earth resources applications, and the management and archiving of science data.

T. C. Fraschetti
(818) 354-6677

Imaging and Spectrometry Systems — Technology development and application for advanced imagers, spectrometers and analytical instruments for remote sensing and *in-situ* environments. Provides technology and tools for end-to-end modeling/Simulation of missions and experiments. Develops advanced algorithms and software for scientific data visualization, analysis and modeling calculation, including state-of-the-art work in parallel and network computing. The Section is in the forefront in research and advanced development of instruments for *in-situ* analysis of chemical species including mass spectrometry, scanning electron microscopy, X-ray diffractometry.

Ray Wall
(818) 354-5016

Jet Propulsion Laboratory

Microwave, Lidar, and Interferometer Technology — Conceive, design, implement and calibrate scientific optical interferometers, microwave through submillimeter wave passive radiometers, and Lidar observational systems. This includes advanced research and technology development and prototype instrument development to support near term and future remote and *in-situ* space missions. Development opportunities for new instrument systems with the user community.

Gary Parks
(818) 354-8053

Space Instruments Implementation — Conception, design development and implementation of remote and *in-situ* sensing systems to enable both NASA and other agencies space science investigations and observations. Specifically, the lead organization responsible for space flight hardware implementation of observational systems. Performs engineering development, test and calibration for flight instrument systems, including optical imaging and spectrometer systems, microwave and submillimeter radiometer systems, and *in-situ* chemical analysis and electron microscopy instruments for remote and landed science investigations.

Chris Stevens
(818) 354-5545

Science Data Processing Systems Develops and applies image processing techniques to the display, analysis, and interpretation of image and image-related data. Utilizes engineering and artificial intelligence to develop automated and semi-automated schemes for data interpretation. Performs research and development in image processing. Also develops and applies specialized software, hardware, and systems architectures to increase the speed of computationally intensive functions on large data sets. Provides image processing and analysis support to the flight projects, imaging teams, and the science community.

Bill Green
(818) 354-3031

Science Data Management and Archiving — Design, develop and operate science data systems for producing archive data products from data generated by NASA's observational instruments. Design, develop and operate data catalog and data access systems using DBMS and hypertext based technologies (such as those underlying the World Wide Web). Implement NASA's educational outreach objectives through the development of multimedia-based educational products available on CD-ROMs or on the WEB. Lead in R&D for archive product and distribution technologies such as CD-ROMs and access to massive data archives.

Tom Renfrow
(818) 306-6044

OFFICE OF ENGINEERING AND MISSION ASSURANCE

Microelectronic Radiation Hardness Assurance — Work is focused on research and testing of the reliability of electronic parts in the harsh radiation environments experienced by NASA spacecraft. Current activities include investigations into radiation effects in electronics and photonics caused by heavy ions characteristic of galactic cosmic rays, electrons, protons and ^{60}Co gamma rays; simulation of single event effects (SEE) by ^{252}Cf; and radiation testing of parts for NASA flight projects. In addition, evaluations are performed of test methodologies and process technologies used to produce reliable, radiation-tolerant microelectronic circuits such as application specific integrated circuits (ASICs), field programmable gate arrays (FPGAs) and large memories (SRAMs, DRAMs).

Charles Barnes
(818) 354-4467

Systems Assurance — Systems Assurance conducts research in wide range of areas concerned with the quality and reliability of spacecraft systems. Research opportunities exist in the modeling, analysis, and simulation of the natural and induced spacecraft mission environments and of their effects on spacecraft systems, subsystems, and individual components. Software reliability

analyses and metrics definition are other areas of rapidly growing research. Specific issues associated with software, spacecraft sensors, control systems, and other flight hardware are of interest.

A. G. Brejcha
(818) 354-3080

Reliability Engineering — Develops reliability and environmental design, analysis, and test requirements for all JPL flight projects. Reliability activities include electrical and mechanical analyses and environmental requirements activities include: thermal, dynamics, electromagnetic compatibility, and natural space environments. Natural environments include solar and planetary thermal conditions, micrometeoroids and space debris, and space plasma. Induced environments include vibration, acoustic, pyrotechnic shock, and thermal loads, electromagnetic effects, spacecraft charging, etc.

J. F. Clawson
(818) 354-7021

Software Product Assurance — Software Product Assurance has the objective to help ensure the operational integrity of the software developed for JPL systems, and evaluates the operational requirements, the acceptability and readiness of all software prior to delivery. It also researches advanced techniques in software engineering, human computer interface, software safety, and metrics, and performs technology transfer to techniques tailored for the JPL and NASA environment to improve the quality of software within JPL and NASA.

R. Santiago
(818) 354-2452

MULTIMISSION OPERATIONS SYSTEM OFFICE (MOSO)

The Multimission Operations Systems Office integrates the development of hardware and software tools to provide efficient and effective multimission operations systems and services to JPL's planetary science projects in order to minimize the cost of mission operations and data analysis. These systems and services include spacecraft analysis and navigation, mission planning and sequencing, science analysis, mission control and data management, computers and communications, and telemetry.

Terry Linick
(818) 354-3161

HPCC/Earth and Space Sciences (ESS) Project — JPL is interested in research which will lead to new parallel computational methods for distributed memory supercomputing architectures. Areas of particular interest include parallel visualization and analysis of massive data sets, methods for writing portable parallel applications and algorithms, performance optimization, and novel parallel numerical techniques. This work is in support of ESS Grand Challenge science applications, which include multi-disciplinary modeling of Earth and space phenomena, and analysis of data from remote sensing instruments.

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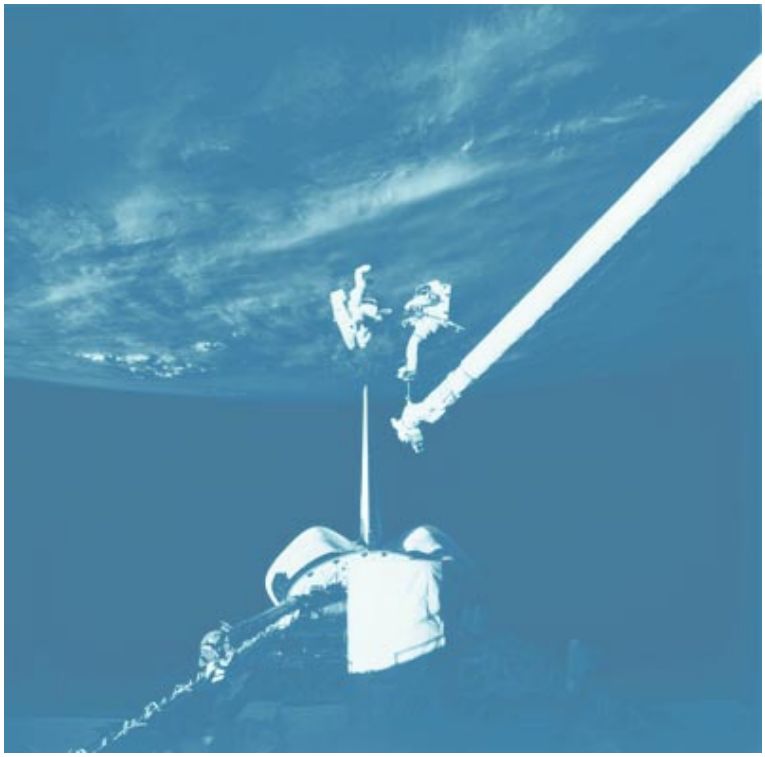
http://olympic.jpl.nasa.gov/



STS-64 Astronauts testing the Simplified Aid for EVA Rescue (SAFER).

Mission

The mission of the Johnson Space Center is the expansion of a human presence in space through exploration and utilization for the benefit of all. The Center is also responsible for leadership in the field of astromaterials.

JSC is the Center of Excellence for Human Operations in Space. This means that JSC provides national leadership and technological preeminence in those capabilities and technologies which support human operations in space. Principal areas include:

- Human spacecraft and habitat design and development
- Human space life sciences
- Flight crew operations
- Mission operations and training
- Planetary surface systems for human operations
- Astromaterials collections, curation, and analysis

JSC is the Lead Center for Space Shuttle Program, Phase I Mir Program, International Space Station Program, Space Operations, Biomedical Research and Countermeasures Program, and the Advanced Human Support Technology Program. Agencywide assignments include Extravehicular Activity (EVA), Robotics Technology Associated with Human Activities, Space Medicine, Technology Utilization on International Space Station and Exploration Mission Planning and Design.

Lyndon B. Johnson Space Center

Houston, TX

The Johnson Space Center is involved in a wide range of activities dealing with human space flight and space exploration. The majority of research areas available for Graduate Student Researchers are in engineering and development and space and life sciences. Additional information concerning the following opportunities may be obtained from the program administrator.

Program Administrator:

Dr. Donn G. Sickorez
University Affairs Officer
Mail Code AP2
NASA
Lyndon B. Johnson Space Center
Houston, TX 77058
(281) 483-4724

ENGINEERING

Advanced Extravehicular (EVA) Systems — The research area includes EVA gloves and advanced thermal protective systems for astronaut space suits, regenerable portable life support subsystems, associated airlock support systems, and equipment that will enhance EVA safety and productivity. For details of research area priority see the technology development road map located on the world wide web at http://www.jsc.nasa.gov/xa/advanced.html

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M. N. Rouen
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Life Support Systems Analysis — The research area includes: l) experimental and theoretical studies leading to greater understanding of biological, chemical, and physical phenomena in air revitalization and water recovery processes; and 2) development of mathematical models for the candidate life support systems for future Moon and Mars missions; and 3) development of automatic control and monitoring techniques at the system level to minimize crew time/effort required for operation of a regenerative life support system.

L. Dall-Bauman
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(281) 483-7633

Spacecraft Thermal Management Systems Research — The research area includes: l) light weight, high efficiency heat pumps and unique heat rejection devices to aid in room temperature heat rejection for advanced missions; 2) theoretical studies and analysis techniques for advanced two-phase thermal management systems; and 3) automated monitor, control, and fault detection methods for advanced two-phase thermal management systems.

E. K. Ungar
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Tracking and Communications — Research opportunities exist in optical and RF sensor systems for autonomous landing and hazard avoidance; digital transmitters and receivers; MMIC distributed array antennas; multi-beam and high-gain electronically steerable antennas; high-rate, free-space optical/laser communications systems with ultrahigh convergence and precision acquisition and tracking capabilities; wireless instrumentation systems; space applications of global positioning system capabilities; space-to-ground HDTV; and orbital debris detection and tracking.

William E. Teasdale
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Advanced Life Support Systems — Current research involves development of regenerative human life support systems

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for future long-duration space missions. Such systems will consist of components which utilize both physicochemical and biological processes to perform the life support functions. Included in these functions are air revitalization, which includes carbon dioxide removal, oxygen generation, and trace gas contaminant control. Water recovery functions include urine treatment, hygiene water processing, and potable water polishing. Food production functions involve crop production using both hydroponic and solid substrate culturing systems as well as automated/robotic systems for plant production. Resource recovery from solid wastes involves such processes as incineration and pyrolysis, and degradation with bacterial bioreactors. Thermal control functions also include energy storage, the use of (rather than rejection of) waste heat, and optical properties assessment for radiative heat storage, the use of (rather than rejection of) waste heat, and optical properties assessment for radiative heat transfer. Additionally, integration of these systems into a functioning regenerative life support system via highly automated control and monitoring systems is critical to current development efforts. Research opportunities exist in chemistry, physics, horticulture and plant physiology, soil science, water chemistry, and environmental, chemical, biological, mechanical, computer, and systems engineering disciplines.

D. L. Henninger
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Guidance, Navigation, and Control — Research opportunities exist for definition/development of guidance, navigation, and control systems for space flight programs. These systems include GN&C software algorithms, navigation sensor hardware, flight control sensor and effector hardware. An advanced technical base is maintained involving test and laboratory facilities and computer simulations to analyze, demonstrate, and test new techniques and concepts. Research opportunities also exist in flight dynamics, aerodynamics/aerothermodynamics, and computational fluid dynamics.

Aldo Bordano
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Flight Data Systems — Research opportunities exist for the following areas of interest: High-speed, radiation tolerant avionic systems; micro-electronic hardware components to enable light-weight, low-power, ultra-reliable avionic systems for long-duration manned space missions; application of standards to spaceflight data system architectures; fault tolerant standards solutions; real-time object oriented software; application of commercial hardware solutions to space flight environments; radiation characterization analysis hardware; mixed signal ASIC design; fault tolerant backplanes; and distributed processing for sensor signal characterization of impending failures. Laboratory facilities exist to support real-time software and fault tolerant research.

William E. Teasdale
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Energy Systems — Attitude control propulsion systems research in the areas of earth storable and cryogenic fluid systems/rocket engine modeling, low gravity fluid behavior and acquisition, rocket engine stability, high temperature materials, cryogenic propellant storage and handling, valving technology, low gravity propellant gauging, and on-orbit health monitoring. Auxiliary Power Unit (APU) research for use of liquid oxygen/hydrocarbon propellants. Electro Mechanical Actuators (EMA) research for application of two fault actuator systems to aerodynamic surface actuation for re-entry vehicles, In-Situ Resource Utilization (ISRU) research to permit utilization of lunar and planetary resources for propulsion propellants and human life support. Power research in areas of energy conversion systems, including long life and high current density fuel cells and electrolysis systems, nickel-hydrogen and lithium batteries, photovoltaic and solar dynamic power systems, automated management and distribution, and thermal energy storage.

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Lyndon B. Johnson Space Center

Thomas Davies
Power Research
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Robotic Simulation — Development of kinematic/dynamic simulations of Shuttle and Space Station telerobots with interactive graphic interfaces is being actively pursued in support of real-time simulation and dynamic analyses. This includes control algorithms for kinematically redundant manipulators, joint servo modeling, control systems interaction, structural contact modeling, and development of simulation architectures. Other areas include multibody dynamic algorithm development (rigid and flexible bodies), friction modeling, and numerical techniques.

Charles J. Gott
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Computer Graphics Research — Development of advanced graphics techniques for robotic realtime man-in-the-loop simulation development, as well as for video documentation of robotic scenarios. This includes research and development of algorithms such as radiosity and ray tracing, developing efficient graphics front ends to simulations which must run in real time, animation, geometric modeling, virtual reality, and telepresence.

Elizabeth Bains
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(281) 483-1551

Artificial Intelligence — Development of technology to support the design, development and operation of space systems and ground support facilities in the areas of: Realtime Intelligent System Monitoring and control; Failure Detection and Diagnosis; Intelligent System Modeling and Analysis; Automated Design Knowledge Capture; Automated Planning and Scheduling; Fault Tolerant Robotic Control and Adaptive Control of Multi-modal High Degree-of-freedom; and Nonlinear Systems. Technologies under development include: Intelligent Computer-Aided Concurrent Engineering; Discrete Event Simulation and Qualitative Modeling; Advanced Human-Machine Interaction Design Methodologies, Object-Oriented Programming Methodologies; Knowledge Representation for Sharable Engineering Knowledge Bases; Intelligent Pattern Recognition and Trend Monitoring; Realtime Expert Systems; Advanced Search and Optimization; Adaptive and Intelligent Control (including Machine Learning, Neural Networks, Fuzzy Logic); Advanced Text Processing and Semantic Classification; Automated Knowledge Acquisition and Data Mining; and Distributed Optimized Planning and Scheduling.

Jon D. Erickson
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(281) 483-1508

Robotic Applications — Development of emerging technologies, such as advanced control schemes (i.e., force/torque feedback and adaptive control), dexterous hands/arms, multi-arm control (for both kinematically sufficient and redundant systems), external sensing, collision detection and avoidance, online path planning, remote control of multiple robots at diverse locations, and application of these technologies to mobile platforms and fixed hand manipulators.

Edith C. Taylor
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Intelligent Robotics — Development of computer software architectures to support human-supervised intelligent robotic systems for human/robot teams in space and development of component technologies such as reasoning, planning, perception, sensing and actuation. Current research is focused on approaches to combining reactive and deliberative planning paradigms to produce robust control schemes for agents operating in dynamic environments.

Jon Erickson
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Nanotechnology — Opportunities exist to improve the laboratory production of Single Walled Carbon Nanotubes (SWNT), or "Buckey Tubes" using the laser vaporization technique. Other vaporization techniques such as inductive heating, inductively coupled plasmas, plasma jets or solar furnaces will be considered for later phases. Potential applications include the structural reinforcement of materials of interest to the future space applications, electronic, magnetic, lubricating, and optical devices.

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Lubert Leger
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Materials and Failure Analysis — Opportunities exist to improve metallic and non-metallic advanced materials development, evaluation, characterization, selection control and failure analysis; contamination modeling and control; measurement standards and calibration; nondestructive evaluation; fracture analysis and fracture control implementation.

Gail Horiuchi
Ghoriuch@ems.jsc.nasa.gov
(281) 483-8927

Manufacturing Process Development — Opportunities exist to produce space flight hardware more efficiently. Of special interest is the development of a seamless integrated process management and control system that can be used in a wide array of manufacturing situations. It should encompass the full range of activities that take place within a unit manufacturing process, such as motion control, process control, and process related diagnostics. It should consider active process control, parametric optimization, and sensor based diagnostic failure detection and compensation.

Gail Horiuchi or C. Salkowski
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Csalkows@ems.jsc.nasa.gov
(281) 483-8927 (G. Horiuchi)
(281) 483-3599 (C. Salkowski)

Manufacturing Technology — Opportunities exist to improve rapid prototype manufacturing of functional prototypes and working models using the Stereolithography (SLA) and Fusion Deposition Modeling (FDM) techniques. To improve composites manufacturing; using fiber placement, filament winding, laminations, pultrusion, Resin Transfer Molding (RTM) techniques. Also to improve the manufacture of miniature mechanical components and electric assemblies, and develop micro and nano technologies to manufacture components for current and future space missions.

Charles Salkowski
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(281) 483-3599

Machine and Assembly — Opportunities exist to improve the ability to rapidly convert drawings and/or computer-aided design (CAD) files into computer-aided manufacturing (CAM) programs. Also to improve the ability of conventional and computer numerical control (CNC) machinery with computer-aided design/ computer-aided manufacturing (CAD/CAM) capability to electronically transfer drawings and CAD files. CAD/CAM operations include milling, turning, electrical discharge machining (EDM), wire electrical discharge machining (WEDM), surface and cylindrical grinding.

Joseph Zamaitis
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(281) 483-2260

Non-Metallic Manufacturing — Opportunities exist to explore applications for a highly diversified range of manufacturing and fabrication functions such as pattern making, molding, encapsulating, potting, and conformal coating of printed circuit boards using a wide range of materials such as wood, thermoplastics, acrylics, polycarbonates (lexan), fiber glass, and an assortment of adhesives. Pattern and mold making include complex laminated patterns, reverse transfer splashing, impression casting and lost wax techniques, and fabrication for injection and compression processes. Also need to improve techniques for fabricating all types of plaques, graphics and photoimaging, including laser engraving, metal finishing of aerospace components, plating of tin, zinc, copper, nickel, rhodium, etc. on metallic and nonmetallic surfaces and on ferrous and nonferrous alloys.

Herbert Mitchell
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Sheet Metal and Welding — Opportunities exist to improve the welding of ferrous and nonferrous alloys using shielded-arc, oxy-fuel, gas tungsten arc, plasma, ultrasonic, friction-stir, resistance spot seam, laser and other emerging technologies. Students will have access to state-of-the-art equipment e.g., sheet metal shears, CNC punchers, programmable benders, CNC waterknives, and sheet metal joiners.

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SPACE & LIFE SCIENCES

Nutritional Biochemistry Research — The present program seeks to define the biochemical, and physiological changes that are related to the integrated physiological response to space flight. The primary goal is to define the nutritional requirements for extended-duration space flight, and to assess efficacy of dietary countermeasures against the negative effects of space flight on the body. Flight-induced changes in calcium metabolism, fluid and electrolyte balance, erythropoiesis, protein metabolism, and general metabolism are being investigated during space flight and using ground based models.

Scott M. Smith, Ph.D.
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Endocrine Biochemistry — Ongoing projects include in vitro and in vivo studies of space flight-related perturbations to calcium, carbohydrate, and protein metabolism, sodium homeostasis, and the reninaldosterone response. Analytical methods are being developed for identifying hormone-binding proteins, antidiuretic hormone, atrial natriuretic hormone, and parathormone. Other methods are being developed to assess electrolytic and hormonal status noninvasively during simulated and actual space flight.

Nitza Cintron
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(281) 483-7046

Immune Responses to Space Flight — The purported detrimental effect of space flight on the immune system has far-reaching implications for maintaining crew health in space, particularly on long missions. Ongoing projects include characterization of receptors on peripheral-blood monocytes by flow cytometry and image analysis; analysis of the antibody response to microbial challenges in vitro; and characterizing changes in microbial physiology as they relate to the risk of infectious disease.

Duane L. Pierson
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(281) 483-7166

Cell Science and Immunology — Ongoing projects include the investigation of space flight effects on human immune function and basic cellular responses to microgravity. These studies include the assessment of cell activation, cell-cell interaction and signal transduction in microgravity culture; investigation of immuno-regulatory factors (cytokines; prostaglandins) and immune cell function during/after space flight; and the determination of humoral immune responses during space flight.

Clarence F. Sams
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(281) 483-7160

Biotechnology and Bioprocessing — Microgravity can be used to facilitate the separation and synthesis of medically important biological materials, as well as to enhance the formation of tissue-like aggregates in specially designed bioreactors. Theoretical and experimental projects are under way to improve cell-culture techniques using normal and neoplastic cell types under microgravity conditions.

Neal R. Pellis
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Pharmacokinetic Research — Space flight appears to alter the disposition of drugs administered to crew members. Characterizing these changes is essential to design effective treatments for illnesses in flight. Bed-rest and in-flight studies are being conducted to identify the physiological changes that influence drug disposition; to develop simple, noninvasive monitoring procedures that can be used in micro-gravity; to develop computer models of pharmacokinetics; and to develop appropriate drug-delivery systems.

Lakshmi Putcha
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Environmental Physiology/ Biophysics Research — The physiological and biophysical interactions of environmental factors such as gas species and their partial pressures, temperature, gravity, decompression and

human subjects, primarily in the are of hypobaric barophysiology, and mathematical models of decompression are currently being pursued. The goal is the understanding of physiological problems to reduce the time impact of countermeasures (e.g., oxygen prebreathe) and developing monitoring equipment.

Michael Powell
michael.r.powell1@jsc.nasa.gov
(281) 483-5413

Psychological Research — The Psychology and Behavior Laboratory conducts investigations to develop effective crew selection, training, and in-flight support procedures and guidelines for manned space missions. Toward this end, specific areas of study include stress and adaptation to extended confinement, team dynamics and leadership, team composition, methods of nonintrusive measurement, cognition, and performance assessment.

Deborah Harm
deborah.1.harm1@jsc.nasa.gov
(281) 483-7222

Neurophysiology — Investigations in the Neuroscience Laboratory are designed to understand the physiological mechanisms involved neurosensory, perceptual, and sensorimotor adaptation to space flight and readaptation to Earth. Included are investigations of eye-head, eye-hand, eye-head-hand coordination, vestibulo-spinal reflexes, posture and gait control processes, perception and spatial orientation processes, and space motion sickness. A major focus of the work in this laboratory is to develop effective countermeasures for the neurosensory disturbances, and motion sickness that occur inflight and upon return to Earth.

Deborah L. Harm
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(281) 483-7222

Exercise Physiology — The Exercise Physiology Laboratory is intimately involved in investigations which support the Space Biomedical Research Institute. The investigators and engineers are also active in the development of future flight hardware for extended space flight. A major aim is to understand the degradations in exercise capacity and the role which exercise may play in the maintenance of normal function in other physiologic systems.

Michael Greenisen
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Cardiovascular Research — The cardiovascular laboratory studies mechanisms of changes to the cardiovascular system as a result of space flight. The primary areas of research include study of changes in cardiac rhythms inflight, including during extravehicular activities, and changes in autonomic control of blood pressure during and after flight.

Janice Yelle
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Space Food Development — The Food Systems Engineering Facility supports food development activities for the Shuttle, International Space Station, and future missions. Lunar base and Mars missions require major efforts in food development especially in packaging and process engineering . Research areas of interest include: food development, food processing, food equipment engineering, acceptability measures for microgravity and isolation, food bioregeneration, shelf life extension up to 5 years, preservation, packaging, and food waste management.

Charles T. Bourland
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Space Radiation — Research in space radiation with the emphasis on the need for crew health protection. The experimental program involves passive dosimetry measurements with thermoluminescent detectors and active dosimetry measurements, which involve development of new charged particle detectors that are flown on the Shuttle. The theoretical program includes the study of and improvements in the trapped radiation belts models, the galactic cosmic radiation models, and studies related to solar energetic particle events.

Gautam Badhwar
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Orbital Debris — The objective of this theoretical and experimental program is to improve the definition of the near-Earth artificial satellite population with an emphasis on understanding the causes and effects of satellite breakups as well as other sources

of orbital debris. Models are developed which combine sources with natural sinks to describe the evolutionary satellite environment for both low and high Earth orbits. Measurements of debris physical properties and flux are performed using optical, infrared, and radar sensors and the examination of impacted surfaces from returned spacecraft or photographs of on-orbit satellites. Hypervelocity guns are used to test spacecraft shielding concepts.

Nicholas Johnson
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Planetary Materials Analysis — Research involves laboratory analysis of lunar rocks, terrestrial rocks, meteorites, and cosmic dust particles to unravel the early geochemical history of solid matter in the solar system, the geologic evolution of planets and rocky protoplanetary objects, including comets, to plan the technology for a lunar base, and for robotic missions to the moon, Mars, and asteroids. Remotely sensed data of Earth and other planetary bodies are also used for these same objectives.

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Earth Observations Database — The NASA Space Shuttle Earth Observations Database is a valuable source of data for research of Earth's recent environmental history, and thus for assessment of the human impact on global Earth processes. This data source, although having the longest length-of-record of any space-derived global change database, has not been fully exploited by scientists studying the global changes.

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Computational Models for Human Factors — Use of computational models of humans and their environments has greatly enhanced and expanded the levels of predictability of performance. This approach is especially effective when it is able to integrate multiple and diverse components for specific and comprehensive solutions. Major areas of research include computer aided design , anthropometric representations, kinematics, light and vision, sound and hearing, strength, speech, task analysis and cognitive behavior. Computational representations of these areas need to be further researched, developed and validated.

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SAFETY, RELIABILITY, AND QUALITY ASSURANCE

Risk Management — Opportunities exist for research in areas related to reliability and safety of space vehicles. Multivariate models, such as logistic regression and proportional hazards models, and system reliability models that make use of dependencies between component failure events are specific topics of interest in statistical reliability. Probabilistic fatigue and other physics-of-failure modeling which may include simulation studies using finite element models are safety topics of interest.

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INFORMATION SYSTEMS

Advanced Training Technologies — Proposals are sought that advance the state-of-the-art in technologies that support training of NASA astronauts and ground-based personnel, including simulations. NASA has a special interest in technologies that will reduce the cost and/or enhance the effectiveness of training and training development. In addition to training, proposals are also sought which could lead to the development of intelligent applications for retrieval, management and understanding of text and other Internet and/or intranet information. Proposals are strongly encouraged that demonstrate a high probability of dual-use in industry and/or education for the developed technologies.

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Kennedy Space Center

STS-72 clears the tower on February 22, 1996.

Mission

Our core business at KSC is "To provide space systems processes, test, and launch techniques, and develop associated technologies."

John F. Kennedy Space Center

Kennedy Space Center, FL

The John F Kennedy Space Center (KSC), located on Merrit Island, Florida, is NASA's primary launch site. The Center is responsible for assuring that sound, safe, and efficient practices and processes are in place for launch site processing; contributes operational expertise to the design and development of new payloads and launch vehicles; and partners with a wide range of entities to develop new technologies for future space initiatives. Areas of research available for Graduate Student Researchers are listed below. Additional information concerning the following opportunities may be obtained from the program administrator.

Program Administrator:

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KSC University Programs Manager
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John F. Kennedy Space Center
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ENGINEERING DEVELOPMENT

Automation and Robotic Ground Support Equipment — The application of current and advanced automation and robotics technologies to time critical, hazardous or repetitive labor intensive Shuttle turnaround and launch processing operations. Specific interest exists in vision inspection systems, mobile robotics systems and controls, intuitive operator interfaces, force torque tracking, adaptive control software and redundancy. Applications under study or development include: remotely installed and verified umbilicals, inspection of orbiter radiators, automated Solid Rocket Booster Nozzle plugs, automated draw bridges, and internal inspection capabilities for small tight, restricted areas.

Communications/Fiber Optics — Continued work with multi and single mode optical fibers exists as well as development activities in optical multiplexing, switching, repeaters, and various fiber optic instrumentation techniques. Applications for research also include high speed baseband and broadband communications in the integrated networking environment and high reliability/redundant dedicated circuits.

Communications/Networks — Research, development, and evaluation of leading edge network architectures, network operating systems, and network protocols. These would be for local area networks(LAN), metropolitan area networks(MAN), wide area networks(WAN) and the Internet. Focus study or analysis would include reduction of implementation and operating costs of existing systems, system expansions, and new systems. This is to be accornplished through the application of new technology, new techniques and consolidation of systems.

RF Digital Communications — Expert in digital radio systems is needed to study the advantages and disadvantages of Spread Spectrum communications methods, for use with voice and data transmission communications systems. Both frequency hopping and direct sequence are to be addressed. Evaluation of Gold, Linear Maximal and Non Linear, and Error Detection and Correction (EDAC) Codes are to be addressed for various applications, and trade-off analyses performed. Various Digital Modulation techniques for use with future Spread Spectrum communications systems are to be studied. The study should also consider a trade-off between circuit complexity and use of fewer, more expensive components.

Acoustics Measurements — Expert in Acoustics Transducers is needed to evaluate methods of verifying performance of microphones, earphones and loudspeakers for present and future communications systems at the Kennedy Space Center. The result of the evaluation should contain recommendations for implementation of an acoustics measurements

John F. Kennedy Space Center

system using standard equipment, as well as production of a short course for maintenance personnel and engineers, that would provide them the ability to perform acoustics measurements using this system.

Instrumentation and Hazardous Gas Detection — Numerous advanced technology projects include hydrazine sensing, mass spectrometry contamination monitors, personnel dosimeters, gas monitors and warning equipment for trace levels of several toxic elements. Other instrumentation projects involve level and flow measurement of cryogenic propellants, new transducers, and state of the art fire detectors.

Intelligent Ground Support Systems — The application of current and advanced software technologies, such as, artificial intelligence and expert systems to improve Shuttle launch and turnaround activities. Research and development includes real-time control and monitoring of complex checkout and launch procedures, automated test procedure development, embedded diagnostics, fault isolation, electronic documentation, distributed database applications, neural net diagnostics and web/Java-based applications. Applications under development or study include: automated launch data reduction and analysis, a web/Java-based application for monitoring launch processing and check out activities, and an expert system to analyze and determine steel failure causes.

BIOLOGICAL PROGRAMS

Advanced Life Support Research — Breadboard Project includes crop growth and production, chemical allelopathy, microbial ecology, biomass conversion, and systems control and automation. May conduct short-term environmental response test for community gas exchange and nutrient uptake. Learn to track gaseous and microbiological contaminants in closed systems. Biomass conversion research in extraction of water-soluble compounds from crop residue, enzymatic hydrolysis of crop residue cellulose, production of edible mycoprotein, conversion of organic particulates and soluble residues from all other reactors into microbial biomass, and aquaculture research. Robotic techniques for planting, culturing, and harvesting crops in a closed growth chamber.

Environmental/Ecological Research — Research on effects on Kennedy Space Center operations on barrier island ecosystems. Studies also include monitoring and assessment of habitat management programs on vegetation, Federally-listed threatened and endangered species, and other protected species found on Kennedy Space Center's wildlife refuge, including Florida scrub jay, bald eagle, gopher, tortoise, manatee, indigo snake, Florida beach mouse, and several species of sea turtle. Studies on use of geographic information systems (GIS) as decision support for environmental monitoring and management.

SPACE BIOLOGY

Gravitational Biology Research — Research on carbon exchange rates and carbohydrate metabolism of higher plants in response to gravity. Includes studies of plant growth with lighting systems proposed for space-flight, such as high-output LEDs, effects of closed atmospheres and ethylene on plants, and development and testing of nutrient delivery and rooting systems for growing plants in microgravity. Studies on changes in gene expression in response to different factors of the spaceflight environment.

PAYLOAD PROCESSING DIRECTORATE

Flight Hardware Engineering — Activities involved in the development and verification testing of space flight hardware in support of life sciences research in space. The challenge is to provide an appropriate environment within the mass, size and power constraints of a Space Shuttle middeck locker. This involves hardware development utilization expertise in mechanical, electrical, electronics and computer hardware and software engineering. Other research tasks involve ground-based and flight verification of the appropriateness of the hardware as a research tool.

Checkout System Development — The Ground Systems Engineering Division provides automated test and checkout capability for

John F. Kennedy Space Center

Expendable Launch vehicle, Space Station, and Shuttle Payload processing. To meet future program requirements, new and innovative capabilities must be developed. These capabilities include the application of development of next generation payload checkout and data acquisition systems. This development activity requires expertise in the fields of computer hardware, software, and network engineering.

ATMOSPHERIC SCIENCES

Lightning Threat Detection — Development of techniques for remote in situ detection and measurement of electric charge and electric fields in and around clouds. Application of traditional or Artificial Intelligence methods to integrating data from radar, surface electric field mills, and several electromagnetic lightning location systems into a single, simple presentation of the magnitude and spatial distribution of the threat of natural lightning and lightning triggered by launch vehicles.

Short-term Local Weather Prediction — Improvement of the capability of mesoscale numerical weather prediction models and other tools for the detailed forecasting of weather specific sites such as the Space Shuttle Landing Facility for forecast lead times from 30 minutes to several hours. Development of methods to maximize the utility of the dense local network of meteorological sensors at Kennedy Space Center and Caper Canaveral Air Station for making short-term site specific operational forecasts.

SAFETY, RELIABILITY AND QUALITY ASSURANCE

Systems Safety — Perform research in the identification and control of hazards, probabilistic risk assessment, fault tree analysis and applications, interactive hazard information tracking and closure systems, reliability engineering.

Quality Engineering — Perform research in the application of statistical process control, methods and analysis, automated assessment techniques and evaluation of inspection methods.

SPACE SHUTTLE PROCESSING

Industrial Engineering — The development of industrial engineering technologies for supporting efforts to improve the efficiency and effectiveness of spacecraft processing. Areas of interest include: operations research, process simulation modeling, statistical process control, data mining experimental design, planning and scheduling systems, project management risk analysis, cost-benefit analysis, methods engineering, work measurement, human factors, ergonomics, facility layout/design, incident analysis, performance metrics, management information systems, and benchmarking.

CHECKOUT AND LAUNCH CONTROL SYSTEM

Launch Processing System Network — The new Launch Processing System has need for a faculty fellow to support development and research associated with modem high speed networks. Specific assignment would be made in the area of developing a prototype network between computers using modern networking techniques such as: reflective memory, asynchronous transfer mode technology, FDDI networks or 100Mb Ethernet. The prototype network would then be benchmarked to examine performance characteristics for trade studies and use in the new LPS Minimum System.

Human Factors — Investigation into the problems of data reduction and presentation. How to transform large real-time data sets into useful information for human decision makers. Includes the application of job and organizational design, equipment and workplace design, environmental design considerations, safety engineering, personnel selection and training, and system evaluation for effective shuttle launch processing.

Human Computer Interaction —The design, evaluation and implementation of interactive computing systems for human use to support the efficiency and effectiveness of spacecraft processing. Involves the application of cognitive engineering principles

to text entry devices, positioning and pointing devices, dialogue construction, visual display prototype development, usability testing, design evaluation, and user support systems.

ADVANCE DEVELOPMENT AND SHUTTLE UPGRADES

Advance Development and Shuttle Upgrades — KSC is reviewing various technologies to upgrade and modify the shuttle fleet and technologies which support further human exploration of space. Areas of interest include: in situ manufacturing of propellants using remote sensing/controls, advanced life support systems, electromechanical actuators technology, advanced avionics systems, neural networks, automated vehicle health management, and liquid oxygen/ethanol propulsion systems.

LOGISTICS OPERATIONS

Materials Science — Investigation of corrosion preventative coatings, accelerated corrosion testing techniques, thermal protective coatings, high pressure oxygen compatibility of materials, cleaning of materials, and shuttle processing improvements of ground support systems.

Langley Research Center

Langley's vacuum spheres used to operate the hypersonic wind tunnel complex.

Mission

In alliance with industry, other agencies, and academia, Langley Research Center develops airframe and synergistic spaceframe systems technologies to assure preeminence of the U.S. civil and military aeronautics and space industries; in alliance with the global research community, Langley pioneers the scientific understanding of the Earth's atmosphere to preserve the environment.

Langley Research Center

Hampton, VA

The mission of the NASA Langley Research Center is to increase the knowledge and capability of the United States in a full range of aeronautics disciplines and in selected space disciplines. The following information provides, by Group, an overview of the current disciplines in the Langley program. Specific research activities associated with each discipline are also included.

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RESEARCH AND TECHNOLOGY GROUP

The Research and Technology Group consist of approximately 800 scientists, engineers, technicians and support personnel who are responsible for performing basic research and technology development in a broad range of aeronautical and selected space disciplines. Through an interdisciplinary approach, the group produces proven and usable technology for aerospace and non-aerospace customers. The Research and Technology Group program include the following types of research activities:

Aerodynamics — Opportunities for research in the aerodynamics area include subsonic aerodynamics, transonic aerodynamics, supersonic aerodynamics, full-scale Reynolds number technology, propulsion integration, takeoff and landing characteristics, applied CFD, wind-tunnel operations, productivity improvements, and advanced test techniques.

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Propulsion Integration

Fluid Mechanics and Acoustics— Opportunities are available in the areas of computational, theoretical and experimental fluid mechanics and acoustics. Fluid mechanics research addresses: the enhanced understanding of viscous flow phenomena including boundary layer transition, turbulence, and separated and vortical flows; modeling of transition, turbulence, and vortical flow phenomena; computational fluid mechanics including accurate and efficient algorithm development; innovative flow control concepts for reducing induced and friction drag, enhancing performance of future high-lift systems, and reducing/increasing mixing; advanced non-intrusive flow diagnostics, and computational multi-disciplinary design optimization systems. Acoustics research addresses the understanding, prediction, and reduction of the noise associated with subsonic and supersonic aircraft. This computational, theoretical and experimental research focuses on engine, rotor, and airframe noise as well as sonic booms generated by supersonic aircraft. Specific areas include: tilt-rotor/helicopter noise, fan and jet noise, propeller noise, laminar flow

Langley Research Center

acoustics, acoustic response, interior noise, sonic fatigue, structural acoustics and noise propagation. The area of computational acoustics represents a major new research thrust.

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Flight Dynamics and Controls — Opportunities to conduct theoretical and applied research in flight dynamics include hazard characterization, detection and avoidance, laminar flow control, high Reynolds number research, and configuration aerodynamics. In the area of controls and guidance, for both aircraft and spacecraft, opportunities exist in multidisciplinary, nonlinear system analysis, design, and implementation, as well as crew station technology. Human factors issues are addressed through research in flight management and vehicle operations technology, advanced human and automation integration, improved cockpit/crew interfaces and decision aids. Research being performed in these areas is targeted for aircraft operating in all speed regimes, as well as to launch systems and orbiting spacecraft.

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Dynamics and Control

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Crew Systems & Operations

Gas Dynamics — Opportunities for research in both focused and basic research and technology development in the areas of aerothermodynamics and hypersonic airbreathing propulsion. Develop, validate, and perform analytical, computational and experimental aerodynamic, aerothermodynamic and fluid physics research to develop, optimize, and evaluate future experimental flight demonstration vehicles and aerospace vehicles. Develop, validate, and perform multidisciplinary research to develop advanced technology for hypersonic airbreathing propulsion systems for aerospace vehicles. The focus is on airframe-integrated engine concepts having high performance over a wide range of flight Mach numbers.

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Gas Dynamics

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Aerodynamics

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Propulsion

Flight Electronics Technology Division — Opportunities for research exist covering flight electronic system sensing, computing, and display for aerospace applications. Flight system sensing includes laser sensing, microwave remote sensing technology including electromagnetic analysis methods, far-field and near-field antenna measurements, compact range technology, and aircraft and spacecraft antenna technology. Computer technology and data processing research areas include optical data processing, solid-state memory technology, very-high-speed information processing, concurrent processing, and highly reliable and fault-tolerant systems.

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Electromagnetic Technology

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Systems Integration

Langley Research Center

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Assessment Technology

Materials

The Materials Division conducts research on advanced materials and nondestructive evaluation (NDE) technologies for aircraft and spacecraft structures. Materials research includes development of high-performance polymers, light alloys and composites, and the processing and manufacturing technologies required to improve performance and reduce weight and cost of aerospace structures. Service life testing is performed to establish durability of these materials under simulated aircraft and spacecraft service conditions. Analyses and modeling are performed to predict structural integrity and develop a fundamental understanding of failure mechanisms. Nondestructive evaluation techniques and methodologies are developed to inspect aircraft and space launch vehicle structures.

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Fatigue and Fracture of Metals and Composites

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Refractory Matrix Composites and Thermal Protection Materials

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Advanced Light Alloy and Metal-Matrix Composites

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High-Performance Polymers and Polymer Matrix Composites

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Nondestructive Evaluation Sciences

Structures

The Structures Division conducts a wide variety of analytical and experimental research aimed towards the development of more efficient structures for aircraft and space vehicles. Research studies focusing on analytical methods for improving structural analysis and design are developed and validated by laboratory experiments. New structural concepts for both metal and composite structures are also developed and evaluated through laboratory testing. Additional research is conducted in integrating advanced structural and active-control concepts to enhance structural performance. Studies of landing and impact dynamics focus on increasing safety during ground operations and crash impact. Research in the aeroelasticity area ranges from unsteady aerodynamics for current and future aircraft and space vehicles to wind tunnel tests of flutter models. The division operates a number of major facilities. These include the Aircraft Landing Dynamics Facility, the Impact Dynamics Research Facility, the Dynamics Testing and Research Laboratory, the Transonic Dynamics Tunnel, and the Structures and Materials Research Laboratory.

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Design for Competitive Advantage

A major problem facing the aerospace industry is how to become more competitive. Decreased cost and increased quality characterize the increased value necessary to improve competitive advantage. This task is to concurrently examine, in the context of competitive advantage, (1) an aerospace product and (2) the system by which we bring forth, sustain, and retire that aerospace product.

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Information and Electromagnetic Technology — Opportunities for research covering information acquisition, information processing and information display for aerospace applications. Information acquisition includes laser sensing, microwave remote sensing technology including electromagnetic analysis methods, far-field and near-field antenna measurements, compact range technology, and aircraft and

spacecraft antenna technology. Information processing and computer technology research areas include optical data processing, solid-state memory technology, very high-speed information processing, concurrent processing and highly reliable and fault-tolerant systems.

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AIRFRAME SYSTEMS PROGRAM OFFICE

The Airframe Systems Program Office (ASPO) is responsible for planning, advocating, and coordinating the Agency's Airframe Systems Research and Technology (R&T) Base Program. Its responsibilities include developing a strategic plan for a range of research programs that blend efforts of NASA Centers, industry, universities, other Government agencies, and other research laboratories. These efforts are aimed at meeting the national goals in aeronautics. ASPO provides program management to ensure that its research supports national needs, that research goals are met in a timely manner, and that resources are used efficiently. Working with the Technology Applications Group and research organizations, ASPO managers ensure timely transfer of technology to internal and external customers.

Within ASPO, the Aeronautics Systems Analysis Division (ASAD) conducts mission and vehicle concept studies to establish the basis for potential new aeronautics research activities. ASAD develops methodologies for integrating discipline technology into efficient vehicle and systems concepts.

AERONAUTICS SYSTEMS ANALYSIS DIVISION

Systems Analysis Branch — The Systems Analysis Branch conducts multidisciplinary studies and analyses of advanced vehicles and the integrated air traffic system. The goals of the branch are:

- Identify high-potential future concepts
- Provide analyses in support of major research programs
- Develop and disseminate advanced system analysis methods and databases

Disciplinary expertise within the branch for conceptual studies includes the following areas:

- Aerodynamics/stability and control
- Propulsion and noise
- Performance and sizing
- Configuration integration and subsystems
- Weights/structures and aeroelastic analysis
- Costs/risks/airspace system and global benefits

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High-Speed

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Subsonic

INTERNAL OPERATIONS GROUP

The Internal Operations Group (IOG) supports the Center's research programs and project activities, with special emphasis on formulating and implementing major policies and programs relating to resources management, acquisition and contracting activities, data systems management, and technical support services. This support also includes the Center's Construction and Facilities program; all functions necessary to design, install, operate, and maintain large mechanical and electrical systems, complex research facilities, and equipment and test apparatus; all functions necessary to provide and maintain institutional buildings, structures, and grounds; all functions necessary to provide design, analysis, fabrication, and operation of complex aerospace systems and research test articles; Center-wide electronic discipline for projects and programs; the operation and maintenance of the Center's central computer complex and simulation facilities; and all functions necessary to operate and maintain the Center's daily flight operations inclusive of aircraft and avionics maintenance, research pilot staff management, and direction of all related design, fabrication, testing, and certification of experimental flight control and display systems.

Langley Research Center

Electronic and Information Systems — This organization pioneers and provides technology, systems, and services in the areas of instrumentation, scientific computing, and simulation to sustain Langley's continued research preeminence. The following items represent active research disciplines.

Advanced Sensor Systems — This activity develops solid-state laser lidar systems, semiconductor detector, and high-temperature superconductor technologies for spaceflight applications.

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Solid-State Laser Technology

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Semiconductor Detector Technology

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Solid-State Laser Materials

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UV & IR Detector Technology

Measurement Science and Instrument Technology — This activity develops far-infrared sensor tech-technology, electromechanical sensors, digital data systems, optical and laser spectroscopy, mass spectrometry and gas chromatography, pressure measurements, thermal measurements, structural dynamics and acoustics measurements, optical interferometry and photogrammetry techniques, and electronics applications.

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Far-Infrared Sensor Technology

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Advanced Electronics and Digital Signal Processing

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Structural Dynamics and Acoustics Measurements

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Aeroelastic Deformation Measurement

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Solid-State Laser Systems

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In Situ (Aircraft-Based) Sensors

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Aerodynamic Force/Moment Measurements

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Pressure Measurements

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Advanced Instrument Pointing and
Tracking and Scanning Systems

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Analog Digital Processing

Langley Research Center

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Aircraft Data Systems

Materials Characterization Technology — This activity includes nondestructive evaluation electromagnetics, ultrasonic propagation and scattering in composites, ultrasonic arrays, signal processing, image analysis, nonlinear acoustics, electron microscopy, microstructural physics, elastic behavior, X-ray tomography, fiber optic sensors, and electronics reliability.

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Microstructure of Polymers

Advanced Computational Capability — This activity includes piloted simulation, computer-generated scientific visualization, image processing, grid generation, numerical techniques for high-performance scientific computers, computer networking technology, user interface development, and mass storage techniques.

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Data Management
User Interface Development

Advanced Computational Capability — This activity includes piloted simulation, computer-generated scientific visualization, image processing, grid generation, numerical techniques for high-performance scientific computers, computer networking technology, user interface development, and mass storage techniques.

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Piloted Simulation

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Scientific Visualization
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Grid Generation
Numerical Techniques for High-Performance Scientific Computers

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Computer Network Technology

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Mass Storage Techniques
Scalable Computing Architectures
World Wide Web (www) Technology

Automated Information Security
This activity develops risk analysis methodology for a distributed systems environment, computer security applications, and system interrogation techniques.

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Automated Information Security

Management Information Systems — This organization handles Business, Administrative, and Management Information Systems development, integration, and operation; technology assessments and assimilation; business process and data modeling; application of expert systems, distributed relational database management systems, image processing systems, and decision support systems; mainframe, client/server, and personal computing platforms.

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Engineering — This activity provides the engineering design and fabrication of flight hardware and research test articles and equipment; the planning and implementation of the Construction of Facilities program and all institutional services in support of the aeronautical and space research programs of the Langley Research Center.

Mechanical Systems Engineering — This activity includes the design, analysis, development, and testing of research systems. These systems include space-borne and aircraft experiments and instruments required to conduct the LaRC research and technology program.

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Langley Research Center

Design and development of mechanical systems for space remote sensing instruments and technology experiments and aeronautics flight experiments. Design of mechanisms, electro-mechanical components, structural systems, terminal control systems, stable optic bench design, structural systems, aircraft structural modifications, and instrumentation packaging.

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Systems level thermal, fluids, and structural analysis and verification of spaceflight and aircraft flight experiments. Includes application of finite element and finite difference methods including the development of CAE tools.

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Facility Systems Engineering — This activity engineers, designs, constructs, and activates aerospace research facilities and equipment for aeronautical and associated institutional facilities for aeronautical and space research. Typical products include low and high speed wind-tunnel facilities and equipment, including tunnel pressure shells and support systems, tunnel internals, automated control systems, devices to facilitate test measurements, process systems, model handling equipment and calibration systems. Other typical products include test cells, simulation equipment, environmental test chambers, clean rooms, laboratories with ancillary systems and equipment, robotics systems, and other specialized research test apparatus/equipment.

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For research in structural finite-element modeling, dynamic structural analysis, heat transfer analysis of aeronautical and space research facilities.

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Engineering Lab Team — Physical and chemical analytical testing services are needed for the operation of facilities at LaRC. Analytical instrumentation is developed that will advance services at LaRC or will advance technology in aeronautics and space projects such as instrumentation for environmental controls, X-ray fluorescence spectroscopy for wear metal, agricultural and geological analysis, flow field and temperature visualization for wind tunnel models, and high temperature superconductive materials magnetic levitation.

Warren C. Kelliher
(757) 864-4172
w.c.kelliher@larc.nasa.gov

Fabrication Division
This office provides support in mechanical, electronics, and materials technology for the Center's engineering and research organizations during the development, fabrication, and testing of research models, flight and related ground support hardware, facility components, and laboratory test apparatus. The office administers contracts of major scope for services and tasks relative to the Center's research manufacturing requirements. The office establishes/implements manufacturing standards and quality assurance procedures in accordance with LaRC's Safety, Reliability, and Quality Assurance Program. The office determines requirements and initiates procurement of advanced manufacturing equipment and directs the development of fabrication processes applicable to unique materials and applications. The office also formulates, establishes, and maintains direct charge system for fabrication support.

S. Stewart Harris, Jr.
Telephone (757) 864-4539
s.s.harris@larc.nasa.gov

Hypersonic Vehicles Office — The Hypersonic Vehicles Office is the Agency lead for hypersonic research and for the development of hypersonic technologies in all disciplines. Results from these activities will have application for both aircraft that cruise within the atmosphere and for launch vehicles that leave the atmosphere. The current major focus is the Hyper-X Program that is an effort to develop and flight test a sub-scale hypersonic airplane configuration which will provide the first demonstration of an airframe-integrated scramjet engine at Mach numbers of 5, 7, and 10.

Langley Research Center

David E. Reubush
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SPACE AND ATMOSPHERIC SCIENCES PROGRAM GROUP

The goal of the Space and Atmospheric Sciences Program Group is to conduct research that will establish and maintain a solid foundation of technology embracing all of the disciplines associated with space and atmospheric sciences; and to provide a wellspring of ideas for advanced concepts. These programs include the following disciplines and specific research activities.

Stratospheric Aerosol and Gas Experiment (SAGE) — Analysis and interpretation of atmospheric aerosol, ozone, nitrogen dioxide, and water vapor measured from SAGE I (1979-81) and SAGE II (1984-present) satellite instruments. Studies are directed toward developing global climatologies of these species and understanding the role these species play in atmospheric processes such as ozone depletion and global warming.

Lamont R. Poole
(757) 864-2689

Climate Research Program — Theoretical, laboratory, and field investigations of the radiative properties of natural volcanic and man-made aerosols and assessment of their impact on regional and global climate. Remote and in-situ observations of cloud properties and radiation balance components and theoretical studies of the role played by clouds in the Earth's radiation balance.

Patrick Minnis
(757)864-5671

Tropospheric Chemistry Research Program — Assess and understand human impact on the regional-to-global-scale troposphere; define chemical and physical processes governing the global geochemical cycles from empirical and analytical modeling studies, laboratory measurements, technology developments, and field measurements; and exploit unique and critical roles that space observations can provide.

James M. Hoell
(757) 864-5826

Upper Atmosphere Research Program — Expand the scientific understanding of the Earth's stratosphere and the ability to assess potential threats to the upper atmosphere. Includes developing empirical and theoretical models, formulating new instruments and techniques, performing laboratory and field measurements, and performing data analysis and interpretation studies.

William L. Grose
(757) 864-5820

Earth Radiation Budget Experiment (ERBE) — Analysis of measurements from instruments on three satellites that provide data on the Earth's radiation budget for assessing climatic impact of human activities and natural phenomena as well as a better understanding of all climatic parameters, in particular, the radiation budget components on a global scale.

Bruce R. Barkstrom
(757) 864-5676

Halogen Occultation Experiment (HALOE) — Analysis and interpretation of measurements from this experiment on the Upper Atmosphere Research Satellite to improve understanding of stratospheric ozone depletion, particularly the impact of chlorofluoromethanes on ozone by analyzing global vertical profile data of O3, HCl, CH4, H2O, NO, NO2, and HF.

John G. Wells
(757) 864-1859

Global Biogeochemical Cycling — Theoretical and field investigations of the biogeochemical cycling of atmospheric gases, with particular emphasis on the global budgets of oxygen, nitrogen, and carbon dioxide to better understand global change. Field measurements include studies of biogenic emissions of atmospheric gases from the soil and oceans and gases produced and released to the atmosphere during biomass burning, i. e., the burning of the world's forests and grasslands.

Joel S. Levine
(757) 864-5692

Transportation Systems — Future space vehicle concept development, operations, research, and computer-aided design.

Charles H. Eldred
(757) 864-8211

Spacecraft System Studies — Spacecraft concept development studies for Global Change science missions; large Earth orbiting spacecraft and platform systems studies; spacecraft subsystem analyses, performance, and technology assessments; mission design; and computer-aided design and simulations.

Richard A. Russell
(757) 864-1935

TECHNOLOGY APPLICATIONS GROUP

The commercial technology mission of NASA requires that each NASA program be carried out in a way that productively involves the private sector from the onset, through a new way of doing business, to ensure that the technology developed will have maximum commercial potential. At Langley, the Technology Applications Group (TAG) is responsible for introducing, facilitating, promoting, and supporting technology transfer and commercialization of advanced aeronautics, space and related technologies.

Technology Transfer/ Commercialization — Transfer of LaRC-developed technologies is to American companies/industries, with emphasis on non-aerospace applications, but team members will also help researchers transfer technologies that only have aerospace applications.

Lance B. Bush
(757) 864-4514

Communication Technology — Dissemination tools for promoting the expedient transfer of technologies over Internet (World Wide Web) and commercial object-oriented electronic distribution models and methodologies.

Stuart E. Pendleton
(757) 864-2943

Panoramic view of Lewis Research Center.

Mission

NASA has designated Lewis Research Center as its Lead Center for Aeropropulsion. Our role is to develop, verify, and transfer aeropropulsion technologies to U.S. industry. As NASA's designated Center of Excellence in Turbomachinery, our role is to develop new and innovative turbomachinery technology to improve the reliability and performance, efficiency and affordability, capacity and environmental compatibility of future aerospace vehicles.

NASA Lewis' other Aeronautics and Space Roles and Missions include: Manage a broad array of aeronautics research and technology propulsion activities including propulsion support technology and propulsion systems analysis; space applications involving power and on-board propulsion, commercial communications and launch vehicles, and microgravity research in the science disciplines of combustion science, fluids physics, and ground-based research.

Lewis Research Center

Cleveland, OH

The Lewis Research Center has a broad research program embracing aeronautical propulsion, space propulsion and power, space electronics, and microgravity science. Brief descriptions of some of the major research activities at Lewis follow.

Qualified applicants are strongly urged to explore areas of interests with the listed contacts, prior to submitting a proposal.

Program Administrator:

Dr. Francis J. Montegani
Office of University Programs
Mail Stop CP-1
NASA
Lewis Research Center
Cleveland, OH 44135
(216) 433-2956

MATERIALS

Ceramic-Matrix Composites — Development of structure/processing/property relationships of ceramic-matrix composites including fibers and fiber coatings for high-temperature, high-reliability requirements for advanced aerospace propulsion and power applications. Various processing approaches, including polymer pyrolysis, melt infiltration, and sol-gel processing, are being pursued. Properties of interest include interface stability flaw distribution, phase morphology, strength, toughness, crack initiation and propagation characteristics, and resistance to environmental attack.

Stanley R. Levine
(216) 433-3276

Tribology and Surface Science — Research to gain a fundamental understanding of the lubrication, adhesion, and wear phenomena of materials in relative motion that meet increased speed, load, and high temperature demands of advanced aerospace propulsion and power systems. Liquid, solid, and vapor phase lubricants are formulated and characterized. Novel foil air bearing designs and advanced solid lubricant formulations for use with these high temperature air bearings are investigated. Surface and interface chemistries and morphologies as well as tribological behavior are examined *in situ* using a variety of techniques including Auger electron and x-ray photoelectron spectroscopy, infrared and Raman microspectroscopy, secondary electron and atomic force microscopy and profilometry.

Mary V. Zeller
(216) 433-2061

Polymers and Polymer Matrix Composites — Development of advanced polymers and polymer matrix composites for use in aerospace propulsion and power and space communications systems. Areas of research include polymer synthesis, characterization, and processing; composite processing, characterization and evaluation; interface studies; polymer/composite aging and life prediction; and determination of structure/property relationships. Research is interdisciplinary and involves work in organic and polymer chemistry, physics, chemical engineering, materials science and engineering, and mechanical engineering.

Michael A. Meador
(216) 433-9518

Environmental Durability of Advanced Materials — Research studies to investigate the mechanisms of degradation and to establish and predict the thermochemical stability limits for advanced materials in the high temperature, hostile environments encountered in advanced aerospace propulsion systems. Oxidation, corrosion, and material compatibility of metals, ceramics, polymers and composite materials are studied in air, inert and simulated environments, and under isothermal and cyclic conditions. Various testing and characterization approaches are used to evaluate

performance and guide the development of the materials and protective coatings (such as thermal barrier, diffusion barrier, interface control) to improve durability, thus extending the useful life and/or temperature capabilities of advanced materials. Plasma spray, chemical vapor, and physical vapor deposition techniques are used to develop and deposit coatings.

Leslie A. Greenbauer-Seng
(216) 433-6781

Metallic Materials — Development of structural metallic materials for aerospace propulsion systems. Intermetallic compounds, superalloys, copper alloys, and composites are being studied for improved performance, higher temperatures, greater durability, and lower cost. Microstructure/property relationships are being developed and experimentally verified. Advanced analytical and microscopy techniques are employed.

Michael V. Nathal
(216) 433-9516

POWER AND ON-BOARD PROPULSION TECHNOLOGY

On-Board Propulsion — Research and development efforts on high performance electric and chemical propulsion system concepts that are candidates for applications ranging from precision positioning of microspacecraft to primary propulsion for planetary exploration. For electric propulsion, electrothermal, electromagnetic, and electrostatic thruster systems are considered with an emphasis on miniaturization for 21st century missions. The low thrust chemical effort focuses on high performance storable bipropellant engines, green monopropellant and bipropellant systems, and miniaturized systems for microspacecraft. Efforts range from basic research to focused development. In addition to thruster system development, heavy emphasis is placed on the identification and resolution of integration issues critical to the user community.

Frank M. Curran
(216) 977-7424
frank.curran@lerc.nasa.gov

Photovoltaic Cells — Fundamental and applied research to increase the efficiency, reduce the weight, and extend the life of solar cells for space applications. Emphasis is on III-V compound solar cells and thin film materials systems. Activities include materials studies; investigations of radiation damage effects; device design, fabrication, and testing; and the development of related component technologies such as cell contact metallurgy and optical concentrators.

Dennis J. Flood
(216) 433-2303

Space Environmental Interactions — Research on electrostatic and electromagnetic effects in space systems and instrumentation (induced by interaction with space plasma and field environments) and on the characterization of local plasma and field environments around large space systems. Effects include surface and bulk dielectric charging, plasma sheath development, current collection from plasma, arcing, and the stimulation and propagation of disturbances. Research disciplines: plasma, solid-state, and surface physics, electromagnetism, and space system design fundamentals.

Dale C. Ferguson
(216) 433-2298

Solar Array Power — Development of new or improved planar and concentrator array technologies, components, and concepts for small spacecraft that are efficient, stowable, lightweight, long-lived, and less costly than present systems. Array design features of interest include optical, electrical, thermal, and mechanical elements. Test, analysis and development activities can also support large spacecraft arrays including structural analysis of deployment mechanisms, testing system operation in simulated space environments, and studies of new array concepts.

Cosmo R. Baraona
(216) 433-5301

Electrochemical Space and Storage — Development of advanced technology to increase the life and energy density of energy storage systems and fuel cells. Emphasis is on nearer-term nickel-hydrogen, metal-hydride, lithium ion and hydrogen-oxygen primary and regenerative fuel cell systems, with exploratory efforts being given to more advanced high-temperature ionic conductor

systems. Pre-prototypes of advanced battery systems are being designed, built and tested.

Marvin Warshay
(216) 433-6126

Space Power Management and Distribution Technology — Research and technology development to control the generation and distribution of electrical energy in aerospace systems, and to define enabling technology for future aerospace power systems. Advanced electrical power systems and circuits such as semiconductor power electronic building blocks, advanced magnetics to facilitate the development of switchgear converters, advanced motor drives for future space and aircraft systems control, devices for actuation and energy storage flywheels are also under active investigation. These components provide core building blocks to construct modular power/drive systems which are analyzed using various design and simulation tools. Circuits technology focuses on electronic motor control and high efficiency/reliability power converters, including single event upset and single event burnout. Systems technology emphasizes automation, improvement in the design process for power systems, and development of integrated power/drive systems.

James F. Soeder
(216) 433-5328

Electro-Mechanical Systems Technology — Program management and technology for efficient, compact, lightweight, long life power systems from tens of watts to megawatts for small spacecraft and high altitude, long endurance unmanned aircraft. Program management and technology for advanced electromechanical actuators for aircraft control surfaces. System and mission studies for space, terrestrial, automotive and aero power systems are conducted to identify requirements and technology needs in the areas of energy conversion, thermal management, power conditioning and control, materials and environmental effects. Development of technology to explore the unique potential of the Stirling cycle engine and heat pump for both space and terrestrial applications. Principal emphasis is on developing the free-piston Stirling engine for space-power systems and advanced technologies for cryogenic space refrigeration systems. Among the areas of research are oscillatory flow and heat transfer, heat pipes, materials, non-contacting bearings, dynamic balancing, linear alternators and motors, and insulation.

James E. Dudenhoefer
(216) 433-6140

Power Materials Technology — Development of new or improved environmentally durable power materials, high emittance radiator surfaces, high reflectance or transmittance solar concentrators, high thermal conductivity materials and high electrical conductivity composites. Power materials and surfaces are developed by means of intercalation techniques, surface modification technology, and development of thin film protective coatings using various deposition techniques. Evaluations of functional performance and durability are conducted for exposure to atomic oxygen, ultraviolet radiation, soft x-rays, vacuum thermal cycling, and effects of interactions with solar flares, as well as lunar and Martian dust.

Bruce A. Banks
(216) 433-2308

Thermo-Mechanical Systems Technologies — Development of technologies for lightweight, high efficiency solar and nuclear thermal power systems. Present emphasis is on the advancement of solar concentrator and heat receiver technologies. Specific concentrator emphasis is related to both rigid and inflatable lightweight structures, reflective and refractive secondary concentrators, high reflectance surfaces and protective films. Heat receiver emphasis is on a heat pipe cavity design with thermal storage. A system conceptual design in 1997 will define advanced solar dynamic technologies required for future space applications.

James E. Calogeras
(216) 433-5278

Thermal Management Technologies — Analytical and experimental efforts to develop the technologies for high performance heat transport components and systems. Concepts include an all silicon multichip module with integrated heat exchanger for space-

based data processing as well as motor control for terrestrial electric vehicles. Zero gravity experiments are being done to demonstrate the feasibility of direct immersion heat pipes for cooling electronics in space. Low mass graphite/aluminum radiators are being built for commercial as well as government applications. A test facility has been built which can evaluate steady state and transient performance of high temperature, high power heat pipes.

Karl W. Baker
(216) 433-6162

INSTRUMENTATION AND CONTROLS TECHNOLOGY

Controls and Dynamics Technology (http://www.lerc.nasa.gov/WWW/cdtb)

Development and demonstration of technologies for advanced control concepts and dynamic modeling that enhance performance, safety, environmental compatibility, reliability and durability of aerospace propulsion systems. The controls technology areas include fault diagnostics, health management, active combustion control, active stall control, turbomachinery system stability management, intelligent engine control, integrated flight/propulsion control, nonlinear and robust multivariable control synthesis techniques, and life extending control. The dynamic modeling work includes modeling of advanced turbomachinery concepts and components, and cross-disciplinary research between controls and computational fluid dynamics (CFD).

Sanjay Garg
(216) 433-2685

Optical Measurement Systems (http://www.lerc.nasa.gov/WWW/OptInstr)

Optical instrumentation technology for aerospace propulsion R&D requirements, for propulsion system control, and for space experiments. This technology includes optical and fiber-optic sensors and laser-based techniques for nonintrusive gas path diagnostics and structures measurements. New systems for both point and whole-field measurements of parameters such as velocity, temperature, and species concentration are conceived and developed in the division's laboratories and applied in Center research facilities.

Carolyn R. Mercer
(216) 433-3411

Sensors (http://www.lerc.nasa.gov/WWW/sensors)

Sensors to support a wide variety of applications which include materials development, structural testing, aero-thermal-structural code validation, controls, and propulsion component and system performance accuracy, high reliability, and survivability. Increasingly hostile measurement system environments make the achievement of these characteristics a major challenge. Measurements of current interest include material surface temperature, strain, heat flux, gas temperature, and gas species. Devices may be MEMS, this film sensors or miniature devices.

W. Dan Williams
(216) 433-3725

High Temperature Electronics Technology (http://www.lerc.nasa.gov///WWW/SiC/SiC.html)

Development of silicon carbide-based, solid-state electronic device technology for high temperature, high radiation, and high power applications, such as advanced aerospace propulsion and power systems. Basic and applied research efforts include silicon carbide crystal growth techniques and all areas of device fabrication technology. Silicon carbide material is being used for MEMS devices as well.

W. Dan Williams
(216) 433-3725

Space Communications Technology

Satellite Networks and Architectures — Analysis of advanced space communications to define and enable future network architectures for commercial and NASA applications. Research using Lewis testbeds related to the use of advanced satellite systems with terrestrial networks (especially the Internet), development of new communications system

architectures and networking concepts, and development of satellite-friendly protocols. Specific areas of interest are Asynchronous Transfer Mode (ATM), Transmission Control Protocol/Internet Protocol (TCP/IP), and applications such as digital video. Also involved are computer modeling of telecommunications networks and simulation of satellite/terrestrial networks using programs such as OpNet.

Kul B. Bhasin
(216) 433-3676

Vacuum Electronics — Research on vacuum electronics to improve the efficiency, operating life, and communications qualities of electron beam devices for use in space communications. Specific technologies of interest are electron emission (including thermionic, field and secondary emission), electron beam formation and control, electromagnetic/electrodynamic computer modeling and design, application of micro-fabrication to vacuum devices, and microwave power modules. State-of-the-art experimental and computational facilities are available.

Vernon O. Heinen
(216) 433-3245

Digital System Technology — Application-focused research and advanced digital technology development for space communications in the areas of modulation and coding, onboard processing, switching and routing, and intelligent systems applications. Specific technologies of interest include: bandwidth and power efficient digital modems and codecs; inter-operable processing satellite architectures; onboard circuit and packet switching; and intelligent assistance for autonomous spacecraft operations.

Edward J. Petrik
(216) 433 3493

Solid State Technology — Research and development of advanced microwave devices and circuits and the technologies required to integrate individual circuit components into microwave subsystems. Research is focused on solid state circuits for transmit and receive modules in the frequency range of 2-110 GHz. Specific technologies under development include planar transmission lines, passive circuit elements, electromagnetic computer modeling, material growth, material characterization, high temperature superconductor microwave circuits, and multilayer microwave circuit components and packaging techniques. State-of-the-art experimental and fabrication facilities include automatic network analyzers, room temperature and cryogenic probe stations, and a clean room.

Vernon O. Heinen
(216) 433-3245

Antenna Technology — Research and advanced development of phased arrays for space communication systems for commercial applications and NASA missions. Emphasis is on development of K/Ka-band arrays/array feeds in which distributed monolithic microwave integrated circuit (MMIC) devices provide amplitude and phase weighting; but alternate, potentially lower cost space fed active array approaches are also of interest. Principal thrusts are on MMIC integration technologies, including MMIC packaging; printed circuit radiating elements and distribution media, beam forming/combining networks and fiber optic links in arrays. Systems and technologies for multiple beams, including digital beamforming are also of interest. State-of-the-art antenna metrology facilities are available.

Charles A. Raquet
(216) 433-3471

Turbomachinery and Propulsion Systems

Compressor Technology — Research to advance compressor technology for gas turbine engines for a wide range of civil and military applications. Areas addressed include advanced axial and radial compressors as well as innovative components such as wave rotors. Experiments to verify selected fluid mechanics computations, allow development of models, and advance understanding of flow physics. State-of-the-art experimental facilities, instrumentation, and data acquisition, reduction, and analysis methods and facilities are employed.

Lawrence J. Bober
(216) 433-3944

Lewis Research Center

Turbine Research & Technology — Research involving the development, assessment, and application of Computational Fluid Dynamics (CFD) tools and models for turbine design and analysis, and the acquisition and analysis of experimental measurements of flow and heat transfer in turbines. The computational emphasis involves the development and validation of advanced computer codes and models, modification of codes and models to extend range and accuracy, application of codes and models to practical problems. Measurements involve both simplified and realistic, complex geometries, and are used both for the validation of advanced numerical flow and heat transfer analysis codes and for the development of new physical models.

Raymond E. Gaugler
(216) 433-5882

Emissions Technology — Experimental and analytical research to advance the understanding of emissions formation in combustion processes in subsonic and supersonic gas turbine aircraft engines. Emittants concerned include oxides of nitrogen, speciation of hydrocarbons and sulfur oxides, and carbon-based gaseous or liquid particulates. Experimental work includes emission characterization in flame tube and sector combustors using advanced diagnostics. Analytical work includes the development of new analytical models for processes such as turbulence-chemistry interaction or the use of advanced computer codes to predict combustion emissions and compare with experimental results. State-of-the-art experimental facilities, instrumentation, analysis methods and computational facilities are employed.

Sol H. Gorland
(216) 977-7561

Aerospace Propulsion Combustion Technology — Research to better understand the basic physical and chemical processes in selected liquid rocket engine technologies that are synergistic to aeronautic propulsion. Disciplines include high-energy propellant chemistry, ignition, combustion, heat transfer and cooling in thrust chambers, nozzle flow phenomena, performance, and combustion stability. Of particular interest are the fundamentals involved in: combustion; cooling; nontoxic and in-situ propellant combustion component technologies; micro-combustor technologies including diagnostics and flow analysis; gas-gas injector technology including stability, performance, and compatibility; laser, combustion wave, and catalytic ignition; low cost combustion devices design; and nonintrusive diagnostics including quantitative supercritical spray characterization. Work is conducted through detailed analytical and experimental programs to determine feasibility or applicability and to develop and validate models to describe the processes.

Sol H. Gorland
(216) 977-7561

Aircraft Icing — Analytical and experimental efforts devoted to developing novel concepts for aircraft ice protection, and fundamental experiments to understand and model the physics of ice formations. Changes in aircraft performance with ice buildup on unprotected components are quantified. Extensive aerodynamic and thermodynamic numerical models are developed and utilized. Interdisciplinary efforts are devoted to developing instruments to characterize icing cloud properties, measure ice accretion on surfaces, and detect changes in aircraft performance in icing conditions. Experimental research is conducted with a specially equipped Twin Otter aircraft and in the Lewis Icing Research Tunnel, the largest refrigerated icing tunnel in the world.

Haeok Lee
(216) 433-3900

Inlet Fluid Mechanics — Experimental and computational efforts devoted to the fluid mechanics of inlets for aerospace propulsion systems for vehicles ranging from subsonic through supersonic and up to hypersonic. Experiments are intended to demonstrate overall inlet performance, investigate specific inlet flowfield phenomena, provide data sets for the validation of computational methods, and increase the understanding of fundamental inlet fluid physics. Computational research involves application of advanced methods to predict inlet aerodynamic performance, development of improved computational models, and development of new methods

gence rates. State-of-the-art experimental facilities, instrumentation, analysis methods and computational facilities are employed.

John M. Abbott
(216) 433-3607

Low Noise Nozzle Technology — Analytical and experimental research on exhaust nozzle aerodynamics and acoustics for high speed commercial transport applications. The goal is to achieve takeoff noise levels competitive with the best subsonic engine technology. Nozzle system research is conducted with advanced computational codes, and experimentally in large dedicated facilities where aerodynamic and far field acoustic performance, and flow details via advanced flow diagnostics can be determined. Fundamental experiments are also performed in smaller facilities to verify selected fluid mechanics computations and to advance understanding of flow physics of advanced mixing and noise suppression processes.

Bernard J. Blaha
(216) 433-3933

Propellant Systems Technology — Research to advance the technology of aeropropulsion propellant systems from ground support equipment to flight and into the low gravity environment. Disciplines include fluid dynamics, heat transfer, thermodynamics and high energy propellant chemistry. Of particular interest are the fundamentals applied to storage, supply and transfer of sub critical cryogens during launch and coast orbits and production, handling and ignition of densified propellants. Work involves development and usage of prediction codes to describe the processes and detailed experimental programs to validate the models.

Joseph D. Gaby
(216) 977-7542

Engine Systems Technology — Analytical and experimental research in propulsion systems for subsonic, supersonic, hypersonic, and space applications. Advanced concepts of interest include rocket-based combined cycles as well as pulse detonation engines. These are developed through systems studies identifying critical component and component integration issues followed by experiments and additional analyses. Research also includes development and application of new techniques, such as advanced numerical methods, grid generation, and turbulence modeling, for analysis of aerospace propulsion systems. Advanced computational technologies, including parallel processing, interactive graphics, database technology and object-oriented techniques, are applied to propulsion system simulation in order to reduce the time and cost of system design. Optimization and inverse design methods are also of interest.

Richard A. Blech
(216) 433-3657

Structures and Acoustics

Turbine Engine Seal Technology — Turbine engine seal technology for next generation aircraft engines having higher power-to-weight ratio, longer life, higher reliability, and higher efficiency. Areas under study include new seal designs, design optimization, high temperature solid film lubrication, performance and durability tests under engine simulated conditions (up to 1500 deg F). New analytical design tools are being developed for predicting seal flow rates, for modeling complete turbine secondary air flow systems in which seals play an integral role, and modeling seal stiffness and damping characteristics. A state-of-the-art turbine engine seal test rig is being fabricated to test seals under all temperature, speed and pressure conditions envisioned for next generation commercial and military turbine engines.

Bruce M. Steinetz
(2l6) 433-3302

Power Transmission Technology — Power train technology for rotorcraft drive systems having higher reliability, longer life and ultrasafe operation, higher power-to-weight ratio, lower noise, lower cost, and higher efficiency. Areas under study include health and useage monitoring systems (HUMS), new gear arrangements and tooth forms, advanced bearing concepts, materials, lubrication, and cooling. New analytical design and optimization tools for stress analysis, vibration, lubrication, and high-speed gears are being developed. Full-scale helicopter transmission test rigs are available for experimental investigations, as are test rigs for fundamental studies of lubrica-

tion, endurance, efficiency, noise of spur, helical, bevel, face, and planetary gear sets.

John J. Coy
(2l6) 433-39l5

Fan/Propeller Aerodynamics and Acoustics — Analytical and experimental investigations of the aerodynamics and acoustics of turbofans for subsonic and supersonic civil transports. Advanced CFD, analytical and computational aeroacoustics methods are applied and compared to experimental data from model scale tests in aeroacoustics wind tunnels. Noise predictions are made using acoustic analogy models in conjunction with aerodynamic predictions. Aerodynamic modeling emphasizes combined effects of fan, nacelle and core flows on system performance and acoustic radiation. New fan and jet noise reduction concepts are developed and evaluated.

Christopher Miller
(216) 433-6179

Advanced Composite Mechanics — Research for development of theories, computational algorithms, and requisite computer codes for the mechanics, analysis, and design of propulsion structures made from high temperature composites. Of interest are polymer matrix, metal matrix, ceramic matrix, and carbon-carbon composites. Research focuses mainly on specialty finite elements for micromechanics and laminate theory; improved theories for life and durability prediction under hostile environment and long time exposure effects; probabilistic composite mechanics; and integrated computer programs for component-specific analysis and design, progressive fracture, acoustic fatigue, damping and high-velocity impact. Selective experimental research is conducted in support of theoretical developments.

Christos C. Chamis
(216) 433-3252

Concurrent Engineering Simulation —Research for developing integrated software packages for the computational simulation of multidisciplinary procedures through which propulsion structural systems are developed, conceived, designed, fabricated, verified, certified, installed, and operated (concurrent engineering). Of interest are simulation models and software packages which consist of: (1) workstations with discipline-specific modules, dedicated expert systems, and local databases; (2) a central executive module with a global database with communication links for concurrent interaction with the multidiscipline workstation; (3) unsupervised-learning neural nets; (4) adaptive methods for condensing and incorporating information as the system evolves; (5) zooming methods; (6) graphic displays; and (7) computer-generated tapes for numerically controlled fabrication machines.

Christos C. Chamis
(216) 433-3252

Probabilistic Structural Mechanics — Research for developing probabilistic structural mechanics, solution/computational algorithms, and requisite computer codes to quantify uncertainties associated with the parameters and variables required for structural analysis and design for both serial and parallel composites. Research focuses mainly on developing probabilistic theories and models for coupled thermal-mechanical-chemical-temporal structural behavior of propulsion structures made from high temperature materials and including metal matrix, ceramic matrix, and carbon-carbon composites and implementation in serial and parallel machines.

Christos C. Chamis
(216) 433-3252

Computational Structures Technology — Development, integration, and demonstration of technology to enhance the role of computational modeling in the design and development process for propulsion and power system structural components. Both efficiency and credibility of computational modeling are of concern so technologies that streamline the design/analysis process as well as improve the fidelity of computational predictions are of interest. Specific areas of interest include computer-integrated simulation, multidisciplinary computational mechanics, design optimization, and artificial intelligence. Simulation includes object-oriented technology, information models, product schema, distributed computing, virtual reality, and human interfaces. Computational mechanics includes fundamental mechanics principles, discrete solution methods, and parallel

computing algorithms. Design optimization includes mathematical programming and optimality algorithms, heuristic methodology, and multidisciplinary design. Artificial intelligence includes expert systems and neural network applications.

Dale A. Hopkins
(216) 433-3260

Structural Dynamics — Development of fundamental methods for predicting and controlling the dynamic response and stability of aerospace propulsion and power systems. This includes analytical and experimental studies of the aeroelastic response of bladed disk systems, and both active and passive methods for controlling the vibration and stability of high-speed turbomachinery. Actively controlled rotors with magnetic suspension are being developed. Technology for long life mechanical components for space mechanism designs is being researched. Advanced computational methods for analyzing multicomponent dynamic systems are being applied.

George L. Stefko
(216) 433-3920

Structural Integrity — Research to assure integrity and reliability of aerospace propulsion and power systems and structural components. Areas of emphasis include interrogational methods for avoiding catastrophic fracture, fault-tolerant design, defect assessment, and residual life prediction. Comprehensive life prediction models are sought that incorporate complex stress states, nonlinear material characteristics, microstructural inhomogeneities, and environmental factors. Structural integrity is verified by nondestructive characterization of microstructure, flaw population, material morphology, and other relevant factors. Nondestructive evaluation is carried out using analytical ultrasonics, computed tomography, laser acousto-ultrasonics, and other advanced interrogational technologies. Modern computer science practices are exploited to the fullest, and emphasis is on advanced structural ceramics and composites. Integrated computer programs for predicting reliability and life of brittle material components are generated.

John P. Gyekenyesi
(216) 433-3210

Deformation and Damage Mechanics — Theoretical and experimental studies of deformation and damage mechanics to develop accurate methods for determining the deformation response and assessing the useful life of structural components operating at elevated temperatures. Typical examples include turbine vanes, blades, and disks; rocket motor combustion chambers, turbines, and nozzle liners; and hot sections of space and terrestrial power systems. Multiaxial, non-proportional, and non-isothermal loading conditions all prevail in such structures. Research focuses on developing (1) constitutive equations, (2) numerical algorithms for analysis and design, and (3) experimental validation of proposed theories and characterization of material response. Materials under investigation include polycrystalline, single crystal, and directionally solidified metals and their alloys; ceramics; and metallic, intermetallic-, and ceramic-matrix/fiber reinforced composites.

J. R. Ellis
(216) 433-3340

Fatigue Life Prediction — Both analytical and experimental approaches are used to develop accurate techniques for predicting durability of aerospace components (turbine vanes, blades, disks, rocket nozzle liners, etc.) subjected to complex service loadings. These are subjected to severe cyclic loads in high-temperature environments. Temperatures are high enough to introduce creep, relaxation, metallurgical transformations, and oxidation. The behavior of materials and structures subjected to such environmental factors is studied in the laboratory, and techniques are developed to allow reliable life prediction in advance of service. Materials under investigation include monolithic alloys and ceramics; and newly developed metallic, intermetallic, and ceramic matrix/fiber reinforced composites.

Fully equipped, computer controlled test systems allow rationale behavior to be investigated under uniaxial and biaxial stress states. Also, advanced scanning electron microscopes, transmission electron microscopes, and micro-

probe facilities are available to investigate fatigue mechanisms at the microstructural level.

J. R. Ellis
(216) 433-3340

MICROGRAVITY SCIENCE

Combustion, Fluid Physics, Transport Phenomena, and Space Processing — Basic science investigations devised to utilize microgravity environment of space to gain new insight in the areas of combustion science, fluid physics and transport phenomena, and space processing science. NASA Lewis Research Center has a world-class and unique suite of ground-based microgravity research facilities that include: a 2.2 second drop tower, a 5-second zero-gravity facility and a reduced-gravity aircraft. These facilities are utilized to conduct microgravity research and to develop space flight experiments for longer duration microgravity experiments conducted on the Space Shuttle and planned for the International Space Station. Well equipped state-of-the-art laboratories are used to develop new diagnostic techniques/ instruments especially suited for use in microgravity research on Earth as well as in space. The experiments conducted in space provide new knowledge that is used to improve processes and equipment used on Earth, as well as for exploration of space.

Howard D. Ross
Combustion Science
(216) 433-2562

Bhim S. Singh
Fluid Physics & Transport Phenomena
(216) 433-5396

Thomas K. Glasgow
Space Processing Science
(216) 433-5013

Marshall Space Flight Center

Aerial view of Marshall Space Flight Center.

Mission

Marshall's vision is to be the world's leader in space transportation systems and microgravity research, and to be a vital resource for the development and utilization of key scientific missions that will advance the frontiers of knowledge and human exploration.

George C. Marshall Space Flight Center

Marshall Space Flight Center, AL

The Marshall Space Flight Center offers opportunities for original work in many areas of physical sciences, mathematics, and engineering. Theoretical and experimental research is greatly enhanced by the ready access to computers, including the Cray XMP.

Before preparing your proposal, prior discussion with a Center researcher is recommended. In general, Marshall advisers are interested in collaborative efforts with students and their university advisers and will look favorably on proposals which indicate that research time will be spent on-site at the Center.

Program Administrator:

Dr. James F. Dowdy
University Affairs Officer
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Flight Center
MSFC, AL 35812
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Email:
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(Federal Express Address:
Building 4481/Room 101)

SPACE SCIENCES LABORATORY

X-ray Astronomy — Experimental, observational, and theoretical research is conducted in x-ray astronomy and high-energy astrophysics. The experimental program concentrates on development of replicated x-ray optics, polarimeters, and hard-x-ray imaging detectors operating from I keV to above 100 keV using microscrip and liquid-xenon technologies. Observational and theoretical specialties comprise the study of compact objects (neutron stars and black holes), cooling flows in clusters of galaxies, and astrophysics of high-temperature plasmas. Opportunities include participation in balloon flights of sensors, analysis of data from the x-ray polarimeter on SPECTRUM-X and other satellites, theoretical studies of physical processes in high-temperature astrophysical plasmas, and observations of clusters of galaxies and the Sunyaev-Zeldovich effect.

M. C. Weisskopf
(205) 544-7740

Biophysics — An opportunity exists to conduct research in the separation and purification of biological cells and proteins to develop a basic understanding of the separation phenomenon. The proposed research should include analysis of the fundamental behavior of a separation process by theoretical and/or experimental methods. A second activity involves laboratory and space experiments in protein crystal growth. High quality single crystals are required to obtain the three-dimensional structure of the proteins, and Shuttle space experiments confirm the advantages of the microgravity environment. Projects include experiments to define improved crystallization conditions and the analysis of crystals by X-ray diffraction.

M. Pusey
(205) 544-7823

Microgravity Solidification — Theoretical and experimental research is conducted on the effects of gravity on the crystal growth or solidification of materials including semiconductors, metals, alloys, polymers, model systems, etc. Both the preparation and the characterization of materials are important. The areas of research include solid-state physics, surface physics, solidification phenomena, fluid modeling, analysis of crystal growth, and characterization techniques such as optical, X-ray, and electron microscopy. In addition to well-equipped laboratories for these activities, the division operates a drop tube 100 meters high.

F. Szofran
(205) 544-7777

Gamma Ray Astronomy — Gamma ray astronomy uses space-borne and balloon-borne experiments to detect hard x-rays and gamma-rays above 20 keV. Most of the present research uses data

from the Burst and Transient Source Experiment (BATSE) on the Compton Gamma Ray Observatory, although data from other spacecraft are also used. The primary astrophysical sources studied include gamma-ray bursts, galactic jets, black hole systems, accreting pulsars, solar flares, as well as the study of variability and spectra of other sources.

G. Fishman
(205) 544-7691

Space Plasma and Upper Atmospheric Physics — We seek to better understand, and ultimately to predict, the flow of matter, momentum and energy through the region in which the Sun-Earth connection is made: the Earth's magnetosphere and ionosphere. We further seek to better understand basic physical processes that effect the operation of spacecraft in space and that are important in astrophysical plasmas; for example cometary, planetary, and stellar upper atmospheres. Plasma and gas dynamic processes are studied by means of in situ plasma measurements, and by remote optical and electromagnetic sensing of the constituent plasmas and gases. Activities include design, development, and calibration of flight instrumentation, with analysis and interpretation of the resulting data in terms of physical models.

P. Craven
(205) 544-7639

Solar Physics — The influence of the magnetic field on the development and evolution of solar atmospheric structure, from the photosphere to the outer heliosphere, is studied. The primary data are vector magnetograms obtained at Marshall's Solar Observatory which are supplemented by data from the Yohkoh, SoHO, Ulysses and the GONG programs. The observations are complemented by theoretical studies to characterize the nonpotential nature of solar magnetic fields. This includes the development of MHD (magnetohydrodynamic) codes designed to simulate both coronal and large scale interplanetary phenomena. Instrument development programs in optical polarimetry, grazing, and normal incidence X-ray optics, and imaging detectors for the X-ray and UV spectral regions are being pursued.

J. Davis
(205) 544-7600

Cosmic Ray Research — Cosmic ray research at MSFC emphasizes the study of the chemical composition and energy spectra of cosmic ray nuclei above 10^{12}eV(JeV). Study of the interactions of heavy cosmic ray nuclei are also carried out to determine the behavior of nucleus interactions and to search for evidence of new states of nuclear matter. The research is carried out with emulsion chambers and with electronic counters, exposed on balloons at about 40 kilometers altitude for up to two weeks. Research includes laboratory work, data analysis, particle cascade calculations, and correlative accelerator experiments.

T. Parnell
(205) 544-7690

SAFETY AND MISSION ASSURANCE OFFICE

Reliability Engineering — Research and analysis are conducted to gain an understanding of complex physics of failure mechanisms with the Space Shuttle Main Engine. The use of statistical models, failure mode and effects analysis, and analysis of failure and anomaly reports, as well as applicable generic data, contribute significantly toward the research efforts.

F. Safie
(205) 544-5278

Quality Assurance Office — Research is performed in areas dealing with software quality control, nondestructive evaluation (radiography, ultrasonic, eddy current), critical process control, use and evaluation of inspection methods, and assessment of critical characteristics in inspection with respect to control of critical items.

R. Mize
(205) 544-2485

Systems Safety Engineering — Opportunities exist for research in the development and implementation of quantitative and qualitative techniques directed at the identification, evaluation, and control of hazards associated with complex space systems. This includes probabilistic risk

assessment, fault tree analysis and applications, interactive hazard information tracking and closure systems, and the identification of conceptual approaches to establishing mission levels and requirements for various types of space missions.

E. Kiessling
(205) 544-7421

MATERIALS AND PROCESSES LABORATORY

Space Environmental Effects on Materials — Evaluation of material is accomplished in simulated space environments involving vacuum, temperature, electron/proton and UV irradiation, atomic oxygen, and *plasma.* The effects of outgassing products of materials on weight loss, strength loss, surface properties, and redeposition and condensation on other items are being studied. Studies involving lubrication and surface physics of bearings in space and in rocket propulsion components are also being conducted. Research and development in new nondestructive evaluation (NDE) methods/processes and instrumentation are encouraged.

M. R. Carruth
(205) 544-7647

Metallic Materials — Development of advanced materials for special applications in space propulsion systems is ongoing. The materials include aluminum-lithium, metal matrix composites and hydrogen resistant alloys. The effect of high-pressure, high temperature hydrogen on metals is an area of special emphasis. Research in microstructural analysis methods is being accomplished in support of failure analysis and materials characterization programs. Methods are being developed for quantitatively determining the state of corrosion, stress corrosion, and hydrogen embrittlement of alloys. Several development efforts are in progress relative to metals processing, including advanced welding methods, intelligent processing, robotics and sensor development.

P. M. Munafo
(205) 544-2566

Nonmetallic Materials Research — Opportunities exist to develop and evaluate various materials for application in adhesives, elastomers, insulators, composite matrices, and molding and extrusion compounds for use in spacecraft hardware and in special environments. Composites utilizing carbon-carbon, carbon-resin, and ceramic matrix are being developed for applications to reduce mass or for high-temperature applications in rocket engines, structures, and leading edges. Research and technology efforts are underway in composite material fabrication, testing, and qualification for flight hardware application including automated filament winding and tape laying, pultrusion, tape wrapping, fiber placement, and hand lay-up. Additional opportunities exist for the development, application, and evaluation of cryogenic and high temperature thermal protection materials used in association with both liquid and solid propellant rocket motors. Also, use of computer aided engineering for process development and optimization including kinematics simulations.

C. R. McIntosh
(205) 544-2620

GLOBAL HYDROLOGY RESEARCH OFFICE

Aerosol Backscatter and Doppler Wind Lidar Studies — The research focuses on the assessment of global and regional patterns of aerosol backscatter, the calibration and characterization of Doppler Lidar systems, and the development of aircraft-and space-based Lidars for the determination of regional and global winds relevant to contemporary issues in atmospheric research. Major experimental efforts have included ground-based and airborne Doppler lidar systems for backscatter and wind fields, intensive field campaigns, and a host of aerosol sensors. Laboratory facilities exist to calitems, and to analyze the optical properties of artificially-generated aerosols which resemble those found in nature. A multi-agency program, which has developed and is flying an airborne Doppler Lidar (MACAWS), will provide a wealth of unique measurement opportunities to support this research.

J. Rothermel
(205) 922-5965

Radar and Hydrometeorology Studies — This research is directed towards understanding precipitation processes and their relation to the larger scale environmental forcing. Cloud microphysics, precipitation processes, storm kinematics, and morphology studies are conducted using ground-based and airborne research data acquired during field campaigns. Ancillary data from satellite and airborne microwave and imaging remote sensor data are used to further describe the convective processes. Data collected from the operational National Weather Service WSR88-D (NEXRAD) network are used to develop climatological rainfall estimates and water budgets to study the interannual variability of rainfall and its relation to changes in the synoptic and general circulation. This research will lead to improved understanding of precipitation processes and algorithms developed for new satellite sensor suites.

S. Goodman
(205) 922-5891

Hydrometeorology/Land Surface Interface — Earth's surface characteristics and their linkages to the atmosphere and hydrologic cycles are being analyzed and modeled using remotely sensed data. Measurements from satellite and aircraft sensors, in conjunction with *in situ* measurements, are used to study spatial and spectral resolution and temporal variability effects on determination of land surface energy fluxes, hydrometeorological characteristics, and biophysical components. The affects of spatial and temporal scale on land surface interface processes is assessed using mesoscale hydrometeorological and Global Circulation Models. Geographic information systems play an important research role in integrating and modeling remote sensing and ancillary data for analysis of the spatial and temporal dynamics of land surface hydrometeorological interactions.

D. Quattrochi
(205) 922-5887

Global Passive Microwave Studies — The Defense Satellite Meteorological Program has launched a series of satellites with passive microwave sensors. These instruments (Special Sensor Microwave Imager, Special Sensor Microwave Temperature-1 and Special Sensor Microwave Temperature-2) are used to detect and measure atmospheric temperature and moisture profiles, bulk atmospheric water vapor and cloud liquid water amounts, precipitation, and land surface temperature and type. Future research in the usage of one or a combination of these data sets for global multi-year or seasonal assessments of hydrometeorological parameters is desired.

M. Goodman
(205) 922-5890

Infrared Water Vapor Measurements — Water vapor is a key component of the Earth's hydrologic cycle. This research focuses on the measurement of atmospheric water to determine bulk water vapor variability and to infer upper-level winds by tracking of water vapor features. Geostationary satellite data from the GOES - VAS and GOES Next satellites are used for local, regional, and hemispheric analysis in support of budget and model studies of the hydrologic and energy cycles.

G. Jedlovec
(205) 922-5966

Atmospheric Electricity Studies — The research is directed toward understanding the physical processes leading to the generation of electrical energy within thunderstorms, developing global lightning climatologies, and understanding the global electric circuit. Modeling, analytic, and observational approaches are used in these studies. Particular emphasis is placed on ground-, aircraft-, and satellite-based optical sensors to study the distribution and variability of global lightning activity. The recently launched Optical Transient Detector and future EOS instruments will play a major role in this research.

R. Blakeslee
(205) 922-5962

H. Christian
(205) 922-5828

S. Goodman
(205) 922-5891

Microwave Measurements — Acquisition and analysis of aircraft and satellite microwave radiometer measurements lead to further understanding of the microphysical processes of

precipitation systems and aid in monitoring global climate change. In this research, aircraft measurements are used to investigate the spatial and temporal structure of precipitation systems, improve inversion techniques for precipitation estimation, for the polarametric retrieval of surface wind velocity over oceans, and for increasing the understanding of heating profiles in tropical atmospheres. Pioneering work with the multi-year MSU satellite data sets are used for global temperature and precipitation studies.

R. Spencer
(205) 922-5960

Atmospheric Chemistry — Measurements of trace species and temperature in the upper troposphere, stratosphere, and mesosphere have been made from the Space Shuttle and other space platforms. These measurements are utilized to study the interactions between chemistry, dynamics, and radiation that are important in Earth's physical climate system. Especially important are the varying concentrations of stratospheric ozone that are determined by these interactions. This research effort utilizes space-based observations along with detailed models of the atmosphere to better understand the processes that determine stratospheric ozone, the interactions between the troposphere and stratosphere (including the role of water vapor), and the influence that human activities have on the atmosphere through the release of chemicals.

T. Miller
(205) 922-5882

Climate Diagnostics and the Global Hydrologic Cycle — Observational, numerical modeling, and analytical approaches are used to study the Earth's physical climate system. Diagnostic analysis of space-based observations are used to understand and validate models of global hydrologic cycle. Numerical models ranging in scope from atmospheric general circulation codes to mesoscale and cloud models are used to study water cycle processes and to quantify their role in climate. Sensitivity studies of climate models to surface boundary forcing, i.e., sea surface temperature, albedo and soil moisture anomalies are conducted. Simulations of remote sensors are used to understand how space-based observations can be best applied to studying the Earth as a system.

F. Robertson
(205) 922-5836

The Role of Global Hydrology and Climate Variability in Human Ecology and Archeology — The study of global hydrology and climate change is directed at understanding how changes in climate can be understood and potentially predicted. A study of past climates and cultures documents the effects of human/environmental interaction. Understanding how prehistoric cultures adapted to their environments through resource management and population dynamics is critical for societies today. Using remote sensing and GIS technology, this research investigates the adaptation techniques of prehistoric societies and compares the resultant success and failure of those techniques with the environmental and socio-economic trends of current populations.

T. Sever
(205) 922-5958

STRUCTURES AND DYNAMICS LABORATORY

Experimental Fluid Dynamics — Opportunities to develop and apply state-of-the-art experimental fluid dynamic methods to study application oriented flow problems. Areas of expertise include external aerodynamics, rotating machinery fluid dynamics, nozzle performance testing, low density environment testing, solid rocket motor internal flow environments, injector performance testing, and many other fields involving fluid flow. Research is needed in all of the above areas, as well as data analysis techniques and unique diagnostic systems development.

W. Bordelon
(205) 544-1579

Structural Dynamics — Activities of interest are aerostructural modeling, vibration analysis, and load predictions using simulation of all environments, including propulsion, control, aerodynamics, and atmosphere. Probabilistic, as well as deterministic, approaches are used on the CRAY to simulate flight and obtain loads data. Enhanced dynamics analysis techniques are pursued.

George C. Marshall Space Flight Center

W. Holland
(205) 544-1495

Thermal Analysis/Liquid Propulsion Systems — Opportunities for research exist in thermal analysis of liquid propulsion system components, including integrated thermal/structural analysis of turbine section and rotating components in high-pressure turbomachinery. Analytical results may be correlated to ground test data.

J. Owen
(205) 544-7213

Thermal Analysis/Solid Rocket Motor — Opportunities are available for research in thermal modeling and analysis of solid rocket motor thermal protection systems. Specific areas include the modeling of ablation processes involving a variety of material surfaces and the determination of heat transfer coefficients in radiative, erosive. and chemically reactive environments.

K. McCoy
(205) 544-7211

Hypervelocity Impact Design and Analysis — Research opportunities are available in the design, analysis, and testing of advance hypervelocity impact shields. Due to the increased space debris, more weight-efficient shields are needed for all future long-term space endeavors. Specific areas include ballistic limit predictions, impact and penetration effects, innovative shield designs for minimum maintenance, quick deployment/ retraction shields, composite material shield design, novel shields, and damage prediction.

G. Olsen
(205) 544-4306

Structural Design Optimization/ Synthesis — In view of the need for lighter, stiffer, and stronger launch and space vehicle structures, new ways of designing structural systems are being sought. Research on the synergistic effects of assembly of structurally optimized elements and components is needed. Efficient and effective design methods and tools using numerical optimization, trajectory analysis, thermal analysis, loads, stress environments, and other critical criteria are needed.

D. Ford
(205) 544-2454

Structural Assessment/Structural Analysis — Opportunities exist for research in strength, stability, fatigue, and fracture mechanics analyses. Computationally intensive methods such as finite and boundary element analyses are used extensively. Practical enhancement methods are sought such as solution adaptive finite element modeling techniques. Technology improvement in analysis and computational methods which lead to development of practical engineering tools are encouraged. The CRAY computer is available for analytical analysis in conjunction with work stations.

C. Bianca
(205) 544-1483

Vibroacoustics — Mechanically and acoustically induced random vibration design and test criteria and response loads analytically derived using advanced computer techniques. Vibration, acoustic, and transient data from engine static firing and Space Shuttle flights are analyzed and categorized. Research opportunities include improved vibroacoustic environment prediction methods and high frequency vibration data analysis techniques.

J. McBride
(205) 544-1523

Computational Fluid Dynamics — Opportunities to develop and apply state-of-the-art computational fluid dynamic (CFD) methods to solve three-dimensional highly turbulent flows for compressible and incompressible, and reacting fluid states, and to provide benchmark CFD, comparisons to establish code quality for subsequent application. Research is needed to assess significant aspects of the computational algorithms, grid generation, chemistry and turbulence modeling code efficiency, and stability, etc.

P. McConnaughey
(205) 544-1599

George C. Marshall Space Flight Center

SYSTEMS ANALYSIS AND INTEGRATION LABORATORIES

Configuration Management — Configuration management is an essential component of any successful engineering activity. Marshall projects tend to be both large and complex as well as small with short durations, requiring the efforts of teams of both NASA and contractor engineers. The level of control required by space flight makes configuration management a critical activity. Automated tools and improved methods are continually sought.

B. Zagrodzky
(205) 544-3293

Systems and Components Test and Simulation — Opportunities exist for the development, qualification, integration, and flight acceptance testing of space vehicles, payloads, and experiments. Thermal vacuum testing is conducted in a variety of chambers with capabilities to 1X10-7 torr and temperature ranges from 149C to +204C. Facilities exist to calibrate X-ray payloads and scientific instruments utilizing a 518-meter evacuated guide tube.

R. Stephens
(205) 544-1336

C. Reily
(205) 544-1298

PROPULSION LABORATORY

Engine Systems Division — Research and development in liquid rocket engines, solid motors, propulsion systems, and reaction control systems. There are activities in solid and liquid propellant combustion, performance prediction, combustion stability, engine risk management, launch and space vehicle propellant, and pressurization systems. Activities include prediction, analysis, and design of propulsion systems, subsystems, components and launch vehicles, and establishing test, integration, and verification requirements for flight and test bed propulsion systems.

H. Pratt
(205) 544-7069

Propulsion Research & Technology Division — Research and technology is ongoing in liquid propulsion systems and non-chemical propulsion systems. Activities include predicting, analyzing, designing, and evaluating advanced, innovative propulsion system for next-generation NASA missions.

L. Jones
(205) 544-7094

Propulsion Development Division — Activities involve research and development for mechanical subsystems such as propulsion feedlines, turbomachinery, combustion devices, thrust vector control, auxiliary propulsion, valves, actuators, controls, mechanisms, and environmental control and life support hardware. Another area of interest is establishing test, integration, and verification requirements for mechanical elements.

C. S. Cornelius
(205) 544-7130

Combustion Devices and Turbomachinery — Investigation of combustion stability, performance, and heat transfer of large rocket engine thrust chambers are of special interest. Techniques for understanding the failure and wear modes and improving the life or propellant cooled anti-friction heatings are needed for reusable rocket engines.

G. Young
(205) 544-7070

Test Division — Activities include experimental research and development testing of propulsion systems, subsystems, and components for space systems hardware. Current specific areas of interest relate to automated test control systems. A continuing interest exists for new and advanced instrumentation techniques.

R. L. Thompson
(205) 544-1247

George C. Marshall Space Flight Center

ASTRIONICS LABORATORY

Electrical Systems — Activities include development of photovoltaic array systems, battery technology and application, and electrical power system automation. Research is conducted in improved photovoltaic cell design and testing. On-site resources include a photovoltaic test laboratory for simulation of on-orbit conditions. Research and application of electrochemistry is utilized to improve space flight batteries with life cycle testing and destructive physical analysis. Artificial intelligence approaches are used to support electrical power system automation.

R. Bechtel
(205) 544-3294

Electronics and Sensors — Research, design, and development of activities are conducted on electronic control systems and measurement sensors for the guidance, navigation, and control of space vehicles. Subjects addressed are sensors, transducers, control actuators, reaction wheels, and pointing systems.

L. J. Cook
(205) 544-3440

Optical Systems — Opportunities exist for research, development, and application of technology in the following areas: coherent lidar systems (both gas and solid state technologies) target and detector calibration, transmitter evaluation signal processing atmospheric propagation and system modeling; video/film camera systems, including imaging systems development fiber optics video compression, radiometry, film camera and video system evaluation; and optical design, fabrication and testing including stray light analysis and testing, performance analysis, coating metrology, precision engineering and binary optics.

J. Bilbro
(205) 544-3467

Audio Systems — Design, development, and evaluation of flight audio communications systems are performed in support of ongoing and future programs. Specific areas of interest include digital signal processing and encoding techniques, voice synthesis and recognition, and the effect on background noise on intelligibility.

P. Clark
(205) 544-3661

Communications Systems — Test facilities are available to pursue research and development of antenna components and systems. These facilities include a fully automated kilometer pattern test range and a shielded anechoic chamber with 3.7 meter diameter quiet zone and supporting test equipment operating up to 60 Ghz. Other areas of interest include high-power, solid-state transmitters and spread spectrum receivers.

L. Bell
(205) 544-3678

Software Systems — An area of high interest is the automatic generation of digital computer code from structured requirements. An area of particular interest is definition of a set of integrated computer aided support tools for software development from requirements phase through validation for embedded computer systems. Another target area of research and development is artificial intelligence techniques and tools to aid in fault diagnosis, load management, and scheduling for flight systems and sub-systems.

R. Stevens
(205) 544-3728

Battery Cell Analysis — Opportunities exist for research into the development of chemical and electrochemical techniques for analysis of aerospace battery cells. These include the modification of analytical techniques to minimize the amount of chemical waste produced and the development of electrochemical impedance spectroscopy as a tool in cell analysis. An important task in the latter is the development of an electrochemical model to be used in interpretation of spectra.

D. H. Burns
(205) 544-4807

George C. Marshall Space Flight Center

MISSIONS OPERATION LABORATORY

Flight Operations — The Mission Operations Laboratory performs functions contributing to the performance of science in space, particularly focusing on development of space science operations capabilities. Payload operations are integrated premission and managed during the on-orbit execution in support of the science users. The operations control function includes command planning, control plans and procedures, and air-to-ground voice management. The data management function includes end-to-end flow analysis and management, requirements development for flight systems, and intercenter data requirements development. The mission planning function includes orbit analysis, mission timelining, flight design, and development of planning systems.

C. Owen
(205) 544-2017

Training/Training Systems — Training on payload operations is provided for the payload crew, payload flight controllers, and investigators using computer simulations, computer-aided training, mock-ups and/or engineering models. Continuous improvement requires that training methods and tools be assessed and updated on a periodic basis. These updates are based on improved capabilities/technology, current information relative to pedagogy and lessons learned from previous training

D. Underwood
(205) 544-2191

Gloria Hullett-Smith
(205) 544-2050

Ground Support Systems — The Huntsville Operations Support Center is the ground facility that supports multi-project flight operations. The design and development function includes communications (voice, video, wideband data handling, and external information transfer), data acquisition and processing, payload and spacecraft commanding user work station data presentation, and facility support functions. Development includes prototyping new technologies to ensure state-of-the-art capabilities, with special emphasis on remote operations linking multiple ground facilities. The facility is managed and operated in support of project and user requirements.

K. Cornett
(205) 544-4321

Human Factors — Human factors analysis in support of flight and ground system development is performed using analytical tools as well as mockups in both l-G and neutral buoyancy zero-G simulations. Human computer interface standards are developed and applied to flight crew tasks and evaluation of control and display devices. New, more effective man/machine interface techniques are evaluated and integrated into design and operational activities.

S. Hall
(205) 544-0517

Expert Systems — New software methods are needed to automate and simplify increasingly complex ground support tasks associated with spacecraft and payload flight operations. Reset projects are projected in the areas of automated analysis of engineering and operations telemetry, decision support, and trend analysis.

M. McElyea
(205) 544-2034

Stennis Space Center

Initial blast of a Space Shuttle main engine test firing.

Mission

The John C. Stennis Space Center (SSC) is NASA's primary center for testing rocket propulsion systems for the Space Shuttle and future generation space vehicles. Because of its important role in engine and vehicle testing over the past three decades, Stennis Space Center has been designated NASA's Center of Excellence for rocket propulsion testing. SSC is located in Hancock County, MS near the Gulf Coast.

SSC is NASA's lead center for the commercialization of remote sensing applications. As such, it works to assist companies involved in environmental consulting, land use planning and natural resource management. SSC also provides the bridge between NASA's Small Spacecraft Technology Program and the private sector for developing commercial remote sensing applications.

The Earth Systems Science Office at SSC engages in research related to the earth system science program of the NASA Mission to Planet Earth Program. Emphasis is given to the study of biological, chemical, and physical processes occurring within the coastal environment (land and ocean) and their interactions.

SSC is unique in that NASA serves as host to 22 other federal and state agencies and university elements located at Stennis, including the U.S. Navy's world-class oceanographic and meteorological command.

John C. Stennis Space Center

Stennis Space Center, MS

Program Administrator:

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TECHNOLOGY

Propulsion System Testing Techniques, Simulation, Modeling, and Methodologies — Research opportunities exist to develop new, innovative techniques to conduct a wide variety of required tests for space systems, stages/vehicles, subsystems and components. Computational Fluid Dynamics modeling and actual hardware testing might be better coupled or integrated. An advanced flexible, dynamic fluid flow simulation and structural modeling graphic interface research tool is desirable for ground test programs of space propulsion systems and components.

Dr. William St. Cyr
(228) 688-1134
William.St_Cyr@ssc.nasa.gov

Cryogenic Instrumentation and Cryogenic, High Pressure, and Ultrahigh Pressure Fluid Systems — Over 40 tons of liquefied gases are used annually in the conduct of propulsion system testing at the Center. Instrumentation is needed to precisely measure mass flow of cryogen's starting at very low flow rates up to very high flow rates at pressures to 15,000 psi. Research, technology, and development opportunities exist in developing instruments to measure fluid properties at cryogenic conditions during ground testing of space propulsion systems. Both intrusive and non-intrusive sensors, but especially non-intrusive sensors, are desired.

Dr. William St. Cyr
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LOX/GOX Compatible Materials — Liquid Oxygen (LOX) and Gaseous Oxygen (GOX) are prime oxidizers for liquid fueled rocket engines and present a danger in material handling. A major need exists for a group of LOX/GOX compatible materials for seats, seals, and solid lubricants for valve and pump components and other uses. Simple, effective, safe techniques to easily and cheaply test or qualify new LOX/GOX compatible materials is desirable.

Dr. William St. Cyr
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Vehicle Health Management/ Rocket Exhaust Plume Diagnostics — A large body of UV-Visible emission spectrometry experimentation is being performed during the 80 or more tests conducted each year on the Space Shuttle Main Engine at SSC. Research opportunities are available to quantify failure and wear mechanisms, and related plume code validation. Related topics include combustion stability, mixture ratio, and thrust/ power level. Vehicle health management/exhaust plume diagnostics experimentation may be readily conducted at the SSC Diagnostics Testbed Facility. Currently, some exploratory studies have been done with emission/absorption spectroscopy, absorption resonance spectros-

copy, laser induced fluorescence, and plume tomography.

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Spectroscopy Technology for Propulsion System Testing — Numerous opportunities exist to advance spectroscopy technology for propulsion system testing. Only a relatively small portion of the electromagnetic spectrum has been investigated for use in propulsion system testing and exhaust plume diagnostics/vehicle health management.

Dr. William St. Cyr
(228) 688-1134
William.St_Cyr@ssc.nasa.gov

Active and Passive Non-intrusive Remote Sensing of Propulsion Test Parameters — The vast amount of propulsion system test data is collected via single channel, contact, intrusive sensors and instrumentation. Future propulsion system test techniques could employ passive non-intrusive remote sensors and active non-intrusive remote sensing test measurements over wide areas instead of at a few discrete points. Opportunities exist in temperature, pressure, stress, strain, position, vibration, shock, impact, and many other measured test parameters. The use of thermal infrared, ultraviolet, and multi-spectral sensors, imagers, and instruments is possible through the SSC sensor laboratory.

Dr. William St. Cyr
(228) 688-1134
William.St_Cyr@ssc.nasa.gov

Ground Test Facilities Technology — Ground test facilities seldom keep pace with propulsion system development programs partly because the facility is usually designed before the test requirements are known and because test facilities are usually extant and inflexible. An innovative approach to producing flexible, easily adaptable ground test facilities is highly desirable. Research opportunities are also available for developing uncertainty models of test facility systems. Additional opportunities exist in developing altitude simulation and self-pumping diffusers for large rocket propulsion system tests.

Dr. William St. Cyr
(228) 688-1134
William.St_Cyr@ssc.nasa.gov

Thermal Protection and Insulation Systems — The test of liquid rocket systems employ very large flame buckets and diffusers to control, deflect, cool, condition, and reduce the sound level of the plume. Innovative thermal protection tiles, coating, or materials, and insulation systems could result in significant savings. Cryogenic lines and vessels typically require expensive vacuum jackets, expansion joints, and devices to maintain the fluids at the required extremely cold and some time high pressure conditions. Better thermal protection and insulation systems might do the same tasks cheaper and require little or no maintenance.

Dr. William St. Cyr
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William.St_Cyr@ssc.nasa.gov

Leak Detection, Sensors, Quantification, and Visualization — Opportunities exist in leak detection technology to determine what is leaking, how much is leaking, where is the source of the leak, and to model and visualize the extent of the effected area. Often hydrogen leaks are the topic of concern because of the explosive nature of hydrogen, and the expense for repairing the leak when eventually found. However, other hazardous and non-hazardous fluid leaks are also of concern. Leaks can occur in compartments and locations where inert gas backgrounds such as nitrogen or helium are present. Portable and/or non-intrusive leak pinpointing techniques are also of interest.

Dr. William St. Cyr
(228) 688-1134
William.St_Cyr@ssc.nasa.gov

Material and Fluid Science — In some cases the basic physics of the material, heat transfer, thermal or fluid science is not understood well enough to model the propulsion system test facility to the required level of sophistication. As more advanced systems are developed, fundamental data is needed to properly design the test facilities. Characterization of collapse factor at pressurant and cryo-

genic fluid interface, cavitation, and thermal stratification are areas of interest. Particular attention is needed to develop materials for LOX service at extreme pressures and to resist hydrogen embrittlement. Research opportunities are available at the 100,000 gallon liquid oxygen barges and the 210,000 gallon liquid hydrogen barges, High Pressure Gas Facility, Gas and Materials Analysis Laboratory, the Advanced Sensor Development Laboratory.

Dr. William St. Cyr
(228) 688-1134
William.St_Cyr@ssc.nasa.gov

Propellant and Pressurants Conservation, Recycling, and Energy Conservation — Large quantities of cryogenic fluids are used to bring propulsion systems and the test facility complexes from ambient temperatures to several hundred degrees Fahrenheit below zero. This chilldown represents a high loss of energy that cost millions of dollars. Research into operations techniques, recovery facilities and equipment, cogenerations and energy management and conservation, could likely improve ground testing to save money and energy.

Dr. William St. Cyr
(228) 688-1134
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Advanced Propulsion Systems Testing — Innovative techniques will be required to test propulsion systems such as advanced chemical engines, single-stage-to-orbit rocket plane components, nuclear thermal, nuclear electric, and hybrids rockets. With a shrinking budget and longer leadtimes to develop new propulsion systems, new approaches must be developed to test future propulsion systems. The solution may be some combination of computational-analytical technique, advanced sensors and instrumentation, predictive methodologies, and possibly subscale tests of aspects of the proposed technology.

Dr. William St. Cyr
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EARTH OBSERVATIONS RESEARCH

Remote Sensing and Plant Physiological Ecology — The detection of plant radiative responses to growth conditions remains as a major goal in remote sensing research. This is true particularly with respect to early detection of plant stress. We are interested in the continued study of leaf and canopy reflectance responses to various stress agents, and the development of techniques to enable the earliest possible detection of stress. This has involved the identification of narrow spectral bands in which reflectance is most strongly affected by various stress agents. We also are continually interested in basic influences on leaf radiative properties, and their relationships to leaf chemical content and physiological processes, particularly photosynthesis.

Dr. Gregory A. Carter
(228) 688-1918
Gregory.Carter@ssc.nasa.gov

Coastal Processes — Focuses on interdisciplinary research related to biogeochemical cycles (biological - physical interactions) and coupling between land and ocean processes. Work includes algorithm development and image processing across multiple computer platforms.

Dr. Richard L. Miller
(228) 688-1904
Richard.L.Miller@ssc.nasa.gov

Research Software — Emphasis on developing efficient software for the analysis and visualization of *in situ* and remotely sensed data for earth science research. Focus is on low-cost computer platforms.

Dr. Richard L. Miller
(228) 688-1904
Richard.L.Miller@ssc.nasa.gov

Archeological/Anthropological Predictive Modeling — Remotely sensed satellite and airborne data can be used to detect anomalies in the surface cover that are representative of prehistoric cultural remains. Sophisticated computer-analysis techniques have been developed to extract archeological/anthropological phenomena from the nonvisible portion of the electromagnetic spectrum. By combining remotely sensed and ancillary information into a data base, accurate predictive models can be developed to isolate

potential locations of prehistoric activity. Various cultures representing diverse environmental conditions are being examined to determine the spectral and spatial characteristics required for archeological/anthropological features detection.

Dr. Marco Giardino
(228) 688-2739
Marco.Giardino@ssc.nasa.gov

Paleoecological Research/Human Adaptations — Focuses on the adaptation of human populations to coastal environments from prehistoric times to the present. Emphasizes interdisciplinary research to develop ecological baselines in coastal zones through the use of remotely sensed imagery, *in situ* field work and the modeling of human population dynamics. Utilizes cultural and biological data from dated archaeological sites to assess the subsistence and settlement patterns of different human societies in response to changing climatic and environmental conditions.

Dr. Marco Giardino
(228) 688-2739
Marco.Giardino@ssc.nasa.gov

COMMERCIALIZATION

Commercial Remote Sensing — The Commercial Remote Sensing Program is designed to establish US preeminence in value-added information products derived from remote sensing and related information technologies. The program is accomplished by conducting collaborative research in application and advanced technology development projects with private firms, universities, and government agencies focused on the following areas: 1) satellite data acquisition, 2) data analysis/product generation, and 3) information distribution and product delivery.

Chuck Hill
(228) 688-2042
Charles.Hill@ssc.nasa.gov

Forms

Proposal Cover Sheet

Abstract and Budget Form

Privacy Act Statement

Certification Regarding Debarment and Suspension

Certification Regarding Drug-Free Workplace Requirements

Proposals Due February 1, 1998

NASA Graduate Student Researchers Program Proposal Cover Sheet

I. Student Information

Name: *Last* _____ *First* _____ *MI* _____

Birth Date: _____ Birth Place: _____

Permanent Residence: _____

City _____ *State* _____ *Zip* _____

Campus Address: _____

City _____ *State* _____ *Zip* _____

Phone: (____) _____ E-Mail: _____

University: _____ GPA: ____/____ Hours: _____

Department: _____ Discipline: _____

Current Degree: _____ Expected Graduation Date: _____

II. Colleges or Universities Attended

Institution *(most recent first)*	Location	Dates *From*	Dates *To*	Degree(s)/Date(s) Awarded/Expected	Major Field
				____/____	
				____/____	
				____/____	
				____/____	

III. Applicant Background *(Check all that are applicable)*

☐ Male ☐ American Native or Alaskan American ☐ Hispanic ☐ Asian ☐ Pacific Islander

☐ Female ☐ African American ☐ White, not Hispanic ☐ Individual with Disabilities

IV. Proposal Information

Type of Proposal: ☐ *New* ☐ *Second Year* ☐ *Third Year*

If Renewal, Designate Grant No.: **NGT -** _____ Proposed Start/Renewal Date: _____

Proposed Title: _____

_____

V. Submission Information *(Check all that are applicable)*

Headquarters

___ Space Sciences
___ Life and Microgravity Sciences and Applications
___ Earth System Science

NASA Centers

___ Ames *(ARC)*
___ Dryrden *(DFRC)*
___ Goddard *(GSFC)*
___ Jet Propulsion Laboratory *(JPL)*
___ Johnson *(JSC)*
___ Kennedy *(KSC)*
___ Langley *(LaRC)*
___ Lewis *(LeRC)*
___ Marshall *(MSFC)*
___ Stennis *(SSC)*

Center Research Advisor _____

Abstract and Budget Form

Student Name: _____ Date of Birth: _____
Last *First* *MI*

VI. Abstract *(100 words or less)*

_____

_____

_____

_____

VII. Budget Information

Prorate Stipend and Allowances if Anticipated Tenure is Less Than 12 Months

Student Stipend **(Maximum of $16,000)** **$**_____

Student Allowance **(Itemize)**

Student Allowance **$**_____
(Maximum of $3,000)

University Allowance **(Itemize)**

University Allowance **$**_____
(Maximum of $3,000)

Total Requested **$**_____
(Maximum of $22,000)

VIII. Faculty Advisor Information

Name: _____

Department: _____

Address: _____

Campus Phone: _____

Fax #: _____

E-mail: _____

*Signature:*_____ *Date:* _____

IX. Official Responsible for Committing Institution

Name: _____

Title: _____

Street Address: _____

City, State, ZIP: _____

Campus Phone: _____

Fax #: _____

Signature: _____ *Date:* _____

I certify that I am a citizen of the United States and that I am or will be a full-time graduate student at the university during the period covered by this proposal.

Signature: _____ *Date:* _____

NASA Use Only **____ Org/Cpys** **____ BdgtFrm** **____ UCert** **____ SAE** **____ Tran** **____ ABS** **____ REC**

Privacy Act Statement

General

Pursuant to Public Law 93-579, Privacy Act of 1974, as amended (5U.S.C.§552a), the following information is being provided to persons who are asked to provide information to obtain a NASA Graduate Student fellowship.

Authority

This information is collected under the authority of the National Aeronautics and Space Act. Publication 85-568, as amended, 42 U.S.C.§2451, et. seq.

Purposes and Uses

This information requested on the application form will be used to determine your eligibility for participation in the NASA Graduate Student Researchers Program. The information requested regarding your ethnic/racial/disability status will be used to determine the degree to which members of each ethnic/racial/disability group are being reached by NASA's announcement of this program, and will not affect your application. Additionally, NASA may disclose this information to other organizations or individuals having relationships with NASA, including but not limited to academic organizations, nonprofit organizations, and other governmental agencies, as well as Congressional offices in response to an inquiry made on your behalf. Disclosure may also be made to concerned parties in the course of litigation, to law enforcement agencies, and to other Federal agencies in exchanging information pertinent to an agency decision.

Effects of Nondisclosure

Furnishing the information on the application form is voluntary, but failure to do so may result in NASA's inability to determine eligibility for participation and selection for award in the Graduate Student Researchers Program. However, your application will not be affected if you choose not to provide information on your ethnic, racial, or disability status.

Definitions for Applicant Background -

American Native or Alaskan American: A person having origins in any of the original peoples of North America and who maintains cultural identification through tribal affiliation or community recognition.
Hispanic: A person of Mexican, Puerto Rican, Cuban, or South American or other Spanish culture or origin, regardless of race.
Asian: A person having origins in any of the original peoples of East Asia, Southeast Asia or the Indian subcontinent. This area includes, for example, China, India, Indonesia, Japan, Korea and Vietnam.
Pacific Islander: A person having origins in any of the original peoples of Hawaii; the U.S. Pacific territories of Guam, American Samoa, and the Northern Marinas; the U.S. Trust Territory of Palua; the islands of Micronesia and Melanesia; or the Philippines.
African American, not of Hispanic origin: A person having origins in any of the black racial groups of Africa.
White, not of Hispanic Origin: A person having origins in any of the original peoples of Europe, North Africa, or the Middle East.
Individual with Disabilities: An individual having a physical or mental impairment that substantially limits one or more major life activities; who has a record of such impairment; or who is regarded as having such impairment.

Certification Regarding
Debarment, Suspension, and Other Responsibility Matters
Primary Covered Transactions

This certification is required by the regulations implementing Executive Order 12549, Debarment and Suspension, 34 CFR Part 85, Section 85.510, Participant's responsibilities. The regulations were published as Part VII of the May 26, 1988 Federal Register (pages 19160-19211). Copies of the regulation may be obtained by contracting the U.S. Department of Education, Grants and Contracts Service, 400 Maryland Avenue, S.W. (Room 3633 GSA Regional Office Building No. 3), Washington, DC. 20202-4725, telephone (202) 732-2505.

(1) The prospective primary participant certifies to the best of its knowledge and belief, that it and its principals:

(a) Are not presently debarred, suspended, proposed for debarment, declared ineligible, or voluntarily excluded from covered transactions by any Federal department or agency;

(b) Have not within a three-year period preceding this proposal been convicted of or had a civil judgment rendered against them for commission of fraud or a criminal offense in connection with obtaining, attempting to obtain, or performing a public (Federal, State, or local) transaction or contract under a public transaction; violation of Federal or State antitrust statues or commission of embezzlement theft, forgery, bribery, falsification or destruction of records, making false statements, or receiving stolen property;

(c) Are not presently indicted for or otherwise criminally or civilly charged by a governmental entity (Federal, State or local) with commission of any of the offenses enumerated in paragraph (1)(b) of this certification; and

(d) Have not within three-year period preceding this application/proposal had one or more public transactions (Federal, State, or local) terminated for cause or default.

(2) Where the prospective primary participant is unable to certify to any of the statements in this certification, such prospective participant shall attach an explanation to this proposal.

Organization Name PR/Award Number or Project Name

Name and Title of Authorized Representative

Signature Date

Certification Regarding Drug-Free Workplace Requirements
Grantees Other Than Individuals

This certification is required by the regulations implementing the Drug-Free Workplace Act of 1988, 34 CFR Part 85, Subpart F. The regulations, published in the January 31, 1989 Federal Register, require certification by grantees, prior to award, that they will maintain a drug-free workplace. The certification set out below is a material representation of fact upon which reliance will be placed when the agency determines to award the grant. False certification or violation of the certification shall be grounds for suspension of payments, suspension or termination of grants, or government wide suspension or debarment (see 34 CFR Part 85, Sections 85.615 and 85.620).

This grantee certifies that it will provide a drug-free workplace by:

(a) Publishing a statement notifying employees that the unlawful manufacture, distribution, dispensing, possession or use of a controlled substance is prohibited in the grantee's workplace and specifying the actions that will be taken against employees for violation of such prohibition;

(b) Establishing a drug-free awareness program to inform employees about -

(1) The dangers of drug abuse in the workplace; (2) The grantee's policy of maintaining a drug-free workplace; (3) Any available drug counseling, rehabilitation, and employee assistance programs, and (4) The penalties that may be imposed upon employees for drug abuse violations in the work place;

(c) Making it a requirement that each employee to be engaged in the performance of the grant be given a copy of the statement required by paragraph (a);

(d) Notifying the employee in the statement required by paragraph (a) that, as a condition of employ ment under the grant, the employee will -

(1) Abide by the terms of the statement; and (2) Notify the employer of any criminal drug statute conviction for a violation occurring in the workplace no later than five days after such conviction;

(e) Notifying the agency within ten days after receiving notice under subparagraph (d)(2) from an employee or otherwise receiving actual notice of such conviction;

(f) Taking one of the following actions, within 30 days of receiving notice under subparagraph (d) (2) , with respect to any employee who is so convicted -

(1) Taking appropriate personnel action against such an employee, up to and including termination; or (2) Requiring such employee to participate satisfactorily in a drug abuse assistance or rehabilitation program approved for such purposes by a Federal, State, or local health, law enforcement, or other appropriate agency;

(g) Making a good faith effort to continue to maintain a drug-free workplace through implementation of paragraph (a), (b), (c), (e), and (f).

Organization Name PR/Award Number or Project Name

Name and Title of Authorized Representative

Signature Date

Earth System Science Fellowship

Space Grant College and Fellowship Program

Earth System Science Fellowship

The NASA Headquarters Office of Mission to Planet Earth (MTPE) supports basic and applied research in Earth system science. The NASA Earth System Science fellowships targets students pursuing advanced degrees in fields supporting the study of Earth as a system.

Program Administrator:

Dr. Ghassem Assar
Office of Mission to
Planet Earth
Code Y
National Aeronautics and
Space Administration
Washington, DC 20546-0001
(202) 358-0273

The near-term (1996-2000) scientific priorities of NASA's Mission to Plant Earth include:

- Seasonal-to-Interannual Climate Prediction: providing global observations and scientific understanding to improve forecasts of the timing and regional extent of transient climate anomalies.
- Long-term Climate Variability: provide global observations and scientific understanding of the mechanisms and factors which determine long-term climate variations and trends.
- Land Cover Change and Global Productivity: document and understand the trends and pattern of changes in land-cover, biodiversity, and global primary production by both oceanic and terrestrial ecosystems.
- Atmospheric Ozone: detecting causes and consequences of changes in atmospheric ozone.
- Natural Hazards: apply unique Mission to Planet Earth remote sensing science and technologies to disaster characterization and risk reduction from earthquakes, fires, floods, droughts and other natural disasters.

Applications will be considered for research on climate and hydrologic systems, ecological systems and dynamics, biogeochemical dynamics, solid Earth processes, human interactions, solar influences, and data and information systems. Atmospheric chemistry and physics, ocean biology and physics, ecosystem dynamics, hydrology, cryospheric processes, geology, and geophysics are all acceptable areas of research, provided that the specific research topic is relevant to NASA's Earth remote sensing efforts in support of the U.S. Global Change Research Program (USGCRP). NASA discourages submission of paleo-climate related applications to this program.

Stipends are identical and most administrative procedures are similar to the GSRP. Approximately forty new fellowships will be awarded in the 1998 academic year.

The NASA Earth System Science Fellowships are awarded through a separate process distinct from the Graduate Student Researchers Program with its own forms and deadlines. Do not use the forms or deadlines contained in this package to apply for Earth System Science fellowships. More detailed information on the Earth System Science Fellowship Program will be available on the Internet in late fall 1997 at *http://www.hq.nasa.gov/office/mtpe* (under "Publications and Education Programs"). Printed copies can be requested by calling (202) 358-3552 and leaving a voice mail message, or by writing:

Earth System Science Fellowships
Office of Mission to Planet Earth
Mail Code YSP-44
NASA Headquarters
300 E Street, SW
Washington, DC 20546

Space Grant College and Fellowship Program

The National Space Grant College and Fellowship Program

Established by Congress in 1989, the National Space Grant College and Fellowship Program contributes to the nation's science and technical enterprise by funding research, education and public service projects through a national network of 52 university-based Space Grant consortia.

Collectively, the consortia have awarded close to 10,000 US citizens with tuition assistance in science and related fields of study. For 1996 individual student awards averaged $2,000 for undergraduates and $8,000 for graduate students. Space Grant colleges and universities also administer pre-college and public service education programs that help to meet the education needs of their states. Space Grant encourages collaboration among departments, across institutions, and with business and industry. All Space Grant programs emphasize diversity of human resources, participation of students in research, and communication of the benefits of science and technology to the public.

The National Program Manager is:

Dr. E. Julius Dasch
jdasch@hq.nasa.gov
Mail Code FE
300 E. Street SW
Washington, DC 20456
(202) 358-1523
Fax (202) 358-3048

Following is a listing of the directors for each consortia.

Alabama Space Grant Consortium
Dr. John C. Gregory
Email: jcgregory@matsci.uah.edu
University of Alabama in Huntsville
(205) 890-6028
Fax (205) 890-6061

Alaska Space Grant Consortium
Dr. Joseph G. Hawkins
Email: ffjgh@uaf.edu
University of Alaska-Fairbanks
(907) 474-5206
Fax (907) 474-6087

Arizona Space Grant Consortium
Dr. Eugene H. Levy
Email: ehl@u.arizona.edu
University of Arizona
(520) 621-4090
Fax (520) 621-8389

Arkansas EPSCoR Consortium
Dr. J. O. Snowden, Director
Email: josnowden@ualr.edu
University of Arkansas
at Little Rock
(501) 569-8212
Fax (501) 569-8039

California Space Grant Consortium
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Email: mwiskerchen@ucsd.edu
University of California, San Diego
(619) 534-5869
Fax (619) 534-7840

Colorado Space Grant Consortium
Ms. Elaine R. Hansen
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University of Colorado
at Boulder
(303) 492-3141
Fax (303) 492-5456

Connecticut Space Grant Consortium
Dr. Ladimer S. Nagurney
Email:
nagurney@uhavax.hartford.edu
University of Hartford
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Fax (860) 768-5073

Delaware Space Grant Consortium
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District of Columbia Space Grant Consortium
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Space Grant College and Fellowship Program

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Indiana Space Grant Consortium
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Iowa Space Grant Consortium
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Kansas Space Grant Consortium
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Kentucky Space Grant Consortium
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Louisiana Space Grant Consortium
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Maine Space Grant Consortium
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Maine Science and Technology
Foundation/EPSCoR
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Fax (207) 621-6369

Maryland Space Grant Consortium
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Massachusetts Space Grant Consortium
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Fax (313) 763-0437

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Fax (601) 232-7577

Missouri Space Grant Consortium
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University of Missouri-Rolla
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Fax (314) 341-4607

Montana Space Grant Consortium
Dr. William A. Hiscock
Email:
billh@orion.physics.montana.edu
Montana State University
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Fax (406) 994-4452

Nebraska Space Grant Consortium
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University of Nebraska at Omaha
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Fax (402) 554-3781

Space Grant College and Fellowship Program

Nevada Space Grant Consortium
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Desert Research Institute
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Fax (702) 895-0496

New Hampshire Space Grant Consortium
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Email: nhspacegrant@unh.edu
University of New Hampshire
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Fax (603) 862-1915

New Jersey Space Grant Consortium
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Email: sthangam@stevens-tech.edu
Stevens Institute of Technology
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Fax (201) 216-8315

New Mexico Space Grant Consortium
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Email: shoran@nmsu.edu
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Fax (505) 646-7791

New York Space Grant Consortium
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Email: terzian@astrosun.tn.cornell.edu
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North Carolina Space Grant Consortium
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North Dakota Space Grant Consortium
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Fax (701) 777-3016

Ohio Space Grant Consortium
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Oklahoma Space Grant Consortium
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South Dakota School of Mines
and Technology
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Fax (605) 394-5360

Tennessee Space Grant Consortium
Dr. Alvin M. Strauss
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Fax (615) 343-6687

Texas Space Grant Consortium
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Fax (512) 471-7363

Space Grant College and Fellowship Program

Utah/Rocky Mountain Space Grant Consortium
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